US Army Corps
of Engineers
Savannah District

Pope Air Force Base
North Carolina

Invitation for Bid
DACA21-98-B-0034
Repair Railcar Offload/Transfer Pumps
LI TMKH986001 A/B
Repair Truck Offload/Receipt Pumps
LI TMKH976004 A/B
Volume III of III
Repair Truck Offload/Receipt Pumps
Technical Provisions - Divisions 2 through 16
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THIS SOLICITATION IS UNRESTRICTED PURSUANT TO THE "BUSINESS OPPORTUNITY DEVELOPMENT REFORM ACT OF 1988" (PUBLIC LAW 100-656)

U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
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SAVANNAH, GEORGIA 31401-3640

Invitation Number
DACA21-98-B-0034

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DEMOLITION

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ENGINEERING MANUALS (EM)

\-EM 385-1-1-\	(1996) U.S. Army Corps of Engineers Safety and Health Requirements Manual

1..2. GENERAL REQUIREMENTS

The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Rubbish and debris shall be removed from Government property daily, unless otherwise directed, to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Contracting Officer. In the interest of occupational safety and health, the work shall be performed in accordance with \-EM 385-1-1-\, Section 23, Demolition, and other applicable Sections. In the interest of conservation, salvage shall be pursued to the maximum extent possible; salvaged items and materials shall be disposed of as specified.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-08 Statements\

Work Plan\; *GA*\.

The procedures proposed for the accomplishment of the work. The procedures shall provide for safe conduct of the work, including procedures and methods to provide necessary supports, lateral bracing and shoring when required, careful removal and disposition of materials specified to be salvaged, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. The procedures shall include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations in accordance with \-EM 385-1-1-\. The work plan shall also identify all off-site waste disposal facilities and include appropriate documentation.

1..4. DUST CONTROL

The amount of dust resulting from demolition shall be controlled to prevent the spread of dust to occupied portions of the construction site and to avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as ice, flooding and pollution.

1..5. PROTECTION

1..5..1. Protection of Personnel

During the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, may be allowed to remain standing without additional bracing, shoring, of lateral support until demolished. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1..5..2. Protection of Existing Property

Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government; any damaged items shall be repaired or replaced as approved by the Contracting Officer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1..5..3. Protection From the Weather

The interior of buildings to remain and salvageable materials and equipment shall be protected from the weather at all times.

1..5..4. Protection of Trees

Trees within the project site which might be damaged during demolition and which are indicated to be left in place shall be protected by a 6 foot high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the work under this contract shall be replaced in kind or as approved by the Contracting Officer.

1..6. BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1..7. USE OF EXPLOSIVES

Use of explosives will not be permitted.

PART 2. PRODUCTS (Not Applicable)

PART 3. EXECUTION

3..1. EXISTING STRUCTURES

Existing structures indicated shall be removed to grade. Interior walls, other than retaining walls and partitions, shall be removed to 2 feet below grade or to top of concrete slab on ground. Basement slabs shall be broken up to permit drainage. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

3..2. UTILITIES

Existing utilities shall be removed as indicated. When utility lines are encountered that are not indicated on the drawings, the Contracting Officer shall be notified prior to further work in that area.

3..3. FILLING

Holes, open basements and other hazardous openings shall be filled in accordance with Section 02210.

3..4. DISPOSITION OF MATERIAL

Title to material and equipment to be demolished, except Government salvage and historical items, is vested in the Contractor upon receipt of notice to proceed. The Government will not be responsible for the condition, loss or damage to such property after notice to proceed.

3..4..1. Salvageable Items and Material

Contractor shall salvage items and material to the maximum extent possible.

3..4..1..1. Material Salvaged for the Contractor

Material salvaged for the Contractor shall be stored as approved by the Contracting Officer and shall be removed from Government property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

3..4..1..2. Items Salvaged for the Government

Salvaged items to remain the property of the Government shall be removed in a manner to prevent damage, and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or

storage shall be repaired or replaced to match existing items. Containers shall be properly identified as to contents.

3..4..2. Unsalvageable Material

Unsalvageable materials shall be classified as to the type of waste in accordance with federal, state, and local regulations and segregated prior to disposal. Disposal of materials outside Government-controlled lands shall be in accordance with federal, state, and local regulations. The location of any disposal facility located outside the limit of Government-controlled lands for each type of waste shall be submitted to the Contracting Officer prior to removal from the project site. The Contractor shall submit documentation from the disposal facility to verify that it is licensed to accept the type of waste. No material shall be removed from the site without prior approval from the Contracting Officer. .

3..5. CLEAN UP

Debris and rubbish shall be removed from basement and similar excavations. Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

3..6. PAVEMENTS

Existing pavements designated for removal shall be saw cut and removed in accordance with the details shown on the drawings and to the limits and to a depth of 12 inches.

ZERO ACCIDENTS

SECTION 02072
REMOVAL AND DISPOSITION OF MATERIALS
AND EQUIPMENT FROM EXISTING FACILITIES

INDEX

1. GENERAL. This section covers the preparation for removal and the removal from the existing piping and equipment of all types including electrical and mechanical items attached to or part of such construction and the subsequent disposal of such removal materials and equipment, as noted on the drawings or otherwise specified to be removed. The procedures to be used shall provide for safe conduct of the work, careful removal and disposition of materials specified to be salvaged, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. The various classifications of removed materials are defined as follows:

1..1. REINSTALLED items are those items which, after removal, are to be reused, reinserted, remounted or otherwise built back into the work under this contract.

1..2. SALVAGED items are those items which, after removal, are to be retained by the Government and delivered for storage on Government premises.

1..3. SCRAPPED items are all other removed materials or equipment. This includes all items which are not noted or specified for reinstallation or salvage.

1..4. SUBMITTALS Submit the following in accordance with Section \=01330=\, "Submittals."

1..4..1. *SD-08, Statements*

a. *Site safety and health plan*; *GA*

b. *Excavation and material handling plan*; *GA*

c. *Field sampling and laboratory testing plan*; *GA*

d. * Piping removal and disposal plan*; *GA*

e. *Qualification*; *GA*

f. *Spill and discharge control plan*; *GA*

1..4..1..1. *Site Safety and Health Plan*; *GA*

Describe safety and health plan and procedures as related to piping and associated equipment removal, and as related to operations associated with petroleum contaminated soils and water. Furnish the name and qualifications

based on education, training, and work experience of the proposed Site Safety and Health Officer.

1..4..1..2. *Excavation and Material Handling Plan* \GA\

Describe methods, means, equipment, sequence of operations and schedule to be employed in excavation, transport, handling, and stockpiling of soil during excavation. Fifteen days before beginning removal work, submit to the Contracting Officer for approval a material handling plan that describes phases of dealing with the contaminated soil and water as it relates to the proposed excavations, including methods of excavating, a material handling plan for the contaminated material, soil testing requirements and safety precautions and requirements.

1..4..1..3. *Field Sampling and Laboratory Testing Plan* *GA\

Describe field sampling methods and quality control procedures. Identify laboratory and laboratory methods to be used for contaminated soil testing. Sample reports shall show sample identification for location, date, time, sample method, contamination level, name of individual sampler, identification of laboratory, and quality control procedures.

1..4..1..4. * PipingRemoval and Disposal Plan* *GA\

Describe methods, means, sequence of operations, and schedule to be employed in the testing, pumping, cleaning, de-vaporizing, inspecting, removal, and disposal of piping.

1..4..1..5. *Qualification* *GA\

Prior to start of work, submit documentation of recent experience and resumes of personnel working on the project.

1..4..1..6. *Spill and Discharge Control Plan* *GA\

Describe procedures and plan related to potential spills and discharge of contaminated soils and wash water.

1..4..2. *SD-18, Records*

a. *Contaminated soil disposal paperwork*; such as laboratory testing reports and treatment facility receipt. *GA\

b. *Contaminated wash water disposal paperwork*; such as laboratory testing results and treatment facility receipt. *GA\

1..5. AREAS OF CONTAMINATION

Assume for bidding purposes that all of the soil encountered during the excavation is contaminated with petroleum and shall be handled as specified herein. Wash water shall be collected and stored, and then removed and disposed of by the Contractor.

1..6. *QUALIFICATION*

Prior to start of work, submit data for approval showing that the piping removal Contractor, subcontractors, and personnel employed on the project have been engaged in removal, transportation, and disposal of piping and associated equipment, are familiar with and shall abide with the following:

a. \-API RP 1604-\.

b. Applicable safety rules and regulations.

c. Use of equipment and procedures for testing and vapor-freeing piping.

d. Handling and disposal of types of wastes encountered in pipe removal including disposal of piping.

e. Excavation, testing, and disposal of petroleum contaminated soils, and liquids.

In addition, furnish data proving experience on at least three prior projects which included types of activities similar to those in this project. Provide project titles, dates of projects, owners of projects, point of contact for each project, and phone numbers of each point of contact.

2. DISPOSITION BY CLASSIFICATION.

2..1. REINSTALLED. Items of material or equipment shown on the drawings or specified to be reinstalled in the work shall be jointly inspected by the Contractor and the Contracting Officer prior to dismantling or removal. An agreement shall be signed briefly setting forth the apparent condition of the material or equipment. Simple operating tests of operative equipment will be included with this joint inspection if feasible. Such items shall be reinstalled as specified in the applicable sections of the specifications covering new items of similar categories.

2..2. SALVAGED. Materials and equipment noted on the drawings or listed to be salvaged shall be carefully handled and protected and shall be delivered to the designated storage areas on the Government premises.

2..3. SCRAPPED. All removed materials and equipment not noted on the drawings or specified to be reinstalled, nor listed to be salvaged, shall be considered as scrap and shall be disposed of by the Contractor off the Government premises and credit for the value thereof, if any, shall have been reflected in the Contractor's bid prices.

3. REMOVALS. Removals of the various construction items shall be as follows:

3..1. CONCRETE. All removed concrete shall be scrapped. Edges of the existing floor slabs indicated to be removed, and which adjoin portions of retained floor slabs, shall first be outlined by scoring the surface to a depth of 2 inches with a concrete saw.

3..2. MISCELLANEOUS METAL. All removed miscellaneous metal including sheet metal items shall be scrapped except fabricated items noted to be reinstalled, which items shall be removed as complete units.

3..3. MECHANICAL. All removed mechanical materials shall be scrapped except items noted to be salvaged or reinstalled. Equipment noted to be salvaged shall have accessory items required for normal operation of the equipment, such as service valves and fittings, salvaged and attached to the unit.

3..4. ELECTRICAL. Electrical fixtures shown to be salvaged shall be cleaned and packaged for protection from breakage. All electrical equipment indicated to be salvaged shall be stored as directed.

4. PROTECTION OF PERSONS AND PROPERTY. During removal operations all persons and property shall be protected as required under CONTRACT CLAUSES "Permits and Responsibilities," "Operations and Storage Areas" and "Cleaning Up." Explosives shall not be used. The work shall proceed in such manner as to minimize the generation and spread of dust and flying particles.

5. DISCONNECTION OF SERVICES. Prior to starting removal operations in a given area, all utility lines which will be affected in that area shall be disconnected unless otherwise indicated or directed. Advance approved arrangements shall be made to prevent interference with utility services to rooms and structures not otherwise affected by work under this contract.

5..1. FIRE ALARM SYSTEMS. Cutting of fire alarm and other circuits shall be accomplished in such manner as to insure continued operation of the systems in the remaining building area.

5..2. PIPE ENDS AND PATCHING. Piping to equipment shall be disconnected at unions, flanges, and valves, or fittings. Except where otherwise noted or directed, protruding portions of abandoned conduit and piping shall be cut off below floor level and back of faces of retained wall and ceiling surfaces, as applicable. Open pipe ends shall be sealed or plugged. Such surfaces shall be patched, replaced or otherwise repaired to a condition comparable to adjacent undisturbed surfaces.

5..3. SAFETY. Precautions shall be taken while dismantling piping containing gas, gasoline, oil, or other explosives or injurious fluids. Such piping shall be stored outdoors until fumes are removed. During installation of new facilities and before removal of existing facilities, the operating and nonoperating utilities or facilities shall be identified for the safety of O&M personnel, the public, firemen, police, and others.

6. HANDLING OF CONTAMINATED MATERIALS

6..1. REMOVAL AND DISPOSAL OF PIPING

Furnish labor, materials, necessary permits, laboratory tests, and reports and equipment to remove and dispose of products remaining in the piping ; clean and vapor free the piping; excavate foundations, and backfill to the level of the adjacent ground; sample soil to determine if contaminated; dispose of piping and petroleum contaminated soil.

6..2. *SITE SAFETY AND HEALTH PLAN*\ (SSHP)

Furnish safety, health, and accident prevention provisions and develop a Site Safety and Health Plan (SSHP). The SSHP shall incorporate the requirements of \-29 CFR 1910-\ and \-COE EM-385-1-1-\ and be prepared, signed and sealed by a Certified Industrial Hygienist. Site work shall not start until the SSHP is approved by the Contracting Officer.

6..3. SITE SAFETY AND HEALTH OFFICER

Identify an individual to serve as the Site Safety and Health Officer (SSHO). The SSHO shall report problems and concerns regarding health and safety to the Contracting Officer. The SSHO shall have a working knowledge of local and Federal occupational safety and health regulations, and shall provide training

to Contractor employees in air monitoring practices and techniques. The SSHO shall also provide day to day industrial hygiene support, including air monitoring, training, and daily site safety inspections. The SSHO shall be trained in the use of the monitoring and sampling equipment, interpretation of data required to implement the SSHP, and to administer the elements of the SSHP. The SSHO shall remain on site during project operations and may be assigned other duties, such as project foreman or quality control manager.

6..4. *SPILL AND DISCHARGE CONTROL PLAN*

Develop, implement, and maintain a comprehensive spill and discharge control plan. The plan shall provide contingency measures for potential spills and discharges from handling and transportation of contaminated soils and water.

6..5. EXCLUSION ZONE (EZ) AND CONTAMINATION REDUCTION ZONE (CRZ)

Do not permit personnel not directly involved with the project to enter work zones, called the EZ and CRZ. The EZ shall be an area around the open piping a minimum of 10 feet from the limits of the piping removal . At the perimeter of the EZ, establish a CRZ. Limits of the CRZ shall be established by the Contractor. Within the CRZ, equipment and personnel shall be cleaned as stated in the paragraph entitled "Personnel and Equipment Decontamination." The Contractor's site office, parking area, and other support facilities shall be located outside the EZ and CRZ. Boundaries of the EZ and CRZ shall be clearly marked and posted. Include a site map, outlining the extent of work zones and location of support facilities, in the SSHP.

6..6. TRAINING

Provide health and safety training in accordance with \-29 CFR 1910-\ prior to starting work. Furnish copies of current training certification statements for personnel prior to initial entry into the work site.

6..6..1. On-Site Training

Prior to starting on-site work, a health and safety training class shall be held by the SSHO to discuss the implementation of the SSHP. Notify the Contracting Officer 24 hours prior to beginning the training class.

6..6..2. Training Outline

Provide the following:

a. Health and safety organization, including discussion of distribution of functions and responsibilities

b. Organization and components of the SSHP

c. Physical and chemical site hazard identification

d. Basic toxicology and toxicity information

e. Discussion of the EZ and CRZ

f. Protective clothing

g. Respiratory protection

h. Air quality monitoring

i. Personnel exposure guidelines

j. Decontamination procedures

k. Basic first aid review

l. Emergency procedures and contingency plan

m. Site entry and exit procedures

n. Sampling procedures

6..7. PERSONNEL PROTECTION

Furnish appropriate personal safety equipment and protective clothing to personnel and ensure that safety equipment and protective clothing is kept clean and well maintained. Furnish three clean sets of personal protective equipment and clothing for use by the Contracting Officer or official visitors as required for entry into the EZ.

6..8. RESPIRATORY PROTECTION PROGRAM

Develop a respiratory protection program, addressing respirator usage and training, in accordance with \-29 CFR 1910-\ and \-COE EM-385-1-1-\.

6..9. DECONTAMINATION

Decontaminate or properly dispose of personal protective equipment and clothing worn in contaminated areas at the end of the work day. The SSHO shall be responsible for ensuring that personal protective clothing and equipment are decontaminated before being reissued.

6..10. FIRST AID AND EMERGENCY RESPONSE EQUIPMENT AND PROCEDURES

Provide appropriate emergency first aid equipment for treatment of exposure to site physical and chemical hazards. Provide and post a list of emergency phone numbers and points of contact for fire, hospital, police, ambulance, and other necessary contacts. Provide and post a route map detailing the directions to the nearest medical facility.

6..11. IGNITION SOURCES

Do not permit ignition sources in the EZ and CRZ.

6..12. PERSONNEL AND EQUIPMENT DECONTAMINATION

Decontaminate personnel and equipment before exiting the work zones.

6..13. WASTE DISPOSAL

The SSHP shall detail the practices and procedures to be utilized to dispose of wastes. Upon completion of the project, certify that equipment and materials were properly decontaminated prior to being removed from the site.

6..14. EMERGENCY RESPONSE REQUIREMENTS

Furnish emergency response and contingency plan in accordance with \-29 CFR 1910-\. In an emergency, take action to remove or minimize the cause of the emergency, alert the Contracting Officer, and institute necessary measures to prevent repetition of the emergency. Equip site-support vehicles with route maps providing directions to the medical treatment facility.

6..15. UNFORESEEN HAZARDS

Notify the Contracting Officer of any unforeseen hazard or condition which becomes evident during work.

6..16. TEMPORARY CONTAINMENT OF EXCAVATED SOIL

Provide temporary containment area near the excavated area. Cover containment area with 30 mil polyethylene sheeting. Place excavated soil on the impervious barrier and cover with 6 mil polyethylene sheeting. Provide straw bale berm around the outer limits of the containment area and cover with polyethylene sheets. Secure edges of sheets to keep the polyethylene sheeting in place.

6..17. EXCAVATION

Notify the Contracting Officer at least 48 hours prior to start of tank removal work. Stage operations to minimize the time that tank excavation is open and the time that contaminated soil is exposed to the weather. Provide protection measures around the excavation area to prevent water runoff and to contain the soil within the excavation area.

6..17..1. Excavation Procedures

Excavate as required for foundations. Place soil removed from the excavation in a temporary containment area. Collect and temporarily store water runoff from stockpiled soils. Contaminated soil shall be tested and disposed of in accordance with North Carolina Department of Environmental Health and Natural Resources.

6..17..2. Excavation Methods

Select methods and equipment to remove soil to minimize disturbance to areas beyond the limits of the excavation area. Material that becomes contaminated as a result of the Contractor's operations shall be removed and disposed of at no additional cost to the Government.

6..18. SPILLS OF CONTAMINATED SOILS

Use appropriate vehicles and operating practices to prevent spillage or leakage of contaminated materials from occurring during operations. Inspect vehicles leaving the area of contamination to ensure that no contaminated materials adhere to the wheels or undercarriage.

6..19. BACKFILL

Provide backfill, compaction, grading, and seeding in accordance with Section \=02210=\, "GRADING".

7. CLEANING UP on a continuing basis shall be provided as required under CONTRACT CLAUSES clause "Cleaning Up."

SECTION 02210

GRADING, EXCAVATION AND BACKFILL FOR STRUCTURES

SECTION 02210

GRADING, EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM D 1556-\	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
\-ASTM D 1557-\	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
\-ASTM D 2167-\	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
\-ASTM D 2487-\	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

1..2. DEFINITIONS

1..2..1. Satisfactory Materials

Materials classified in \-ASTM D 2487-\ as SP, SC, SM, CL, CH, ML, GM, GW, GP, and SW, and free from roots and other organic matter, trash, debris, and frozen materials and stones larger than 6 inches in any dimension are satisfactory.

1..2..2. Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Materials classified in \-ASTM D 2487-\ as MH, Pt, OH, and OL are unsatisfactory. Unsatisfactory materials also include man-made fills, refuse, or backfills from previous construction.

1..2..3. Cohesionless and Cohesive Materials

Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Cohesionless materials include materials classified in \-ASTM D 2487-\ as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines have a plasticity index of zero.

1..2..4. Degree of Compaction

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in \-ASTM D 1557-\ abbreviated below as a percent of laboratory maximum density.

1..2..5. Topsoil

Material obtained from offsite areas and/or excavations.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-09 Reports\

Field Testing Control\; *FIO*\.

Copies of all laboratory and field test reports to the Contracting Officer within 24 hours of the completion of the test.

PART 2. PRODUCTS

2..1. NOT USED

2..2. BORROW MATERIAL

2..2..1. Selection

Borrow materials shall be obtained from sources outside the limits of Government-controlled land. Borrow materials shall be subject to approval. The source of borrow material shall be the Contractor's responsibility. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, shall pay all royalties and other charges involved, and shall bear all the expense of developing the sources, including rights-of-way for hauling.

2..2..2. Borrow Pits

Except as otherwise permitted, borrow pits shall be excavated to afford adequate drainage. Overburden and other spoil material shall be disposed of or used for special purposes. Borrow pits shall be neatly trimmed after the excavation is completed.

PART 3. EXECUTION

3..1. CONSERVATION OF TOPSOIL

Where indicated, topsoil shall be removed to a depth of 4 inches without contamination with subsoil and stockpiled convenient to areas for later application or at locations specified. Topsoil shall be removed to full depth and shall be stored separate from other excavated materials and piled free of roots, stones, and other undesirable materials. Any surplus of topsoil from excavations and grading shall be removed from the site.

3..2. EXCAVATION

Excavation of every description, regardless of material encountered, within the grading limits of the project shall be performed to the lines and grades indicated. Satisfactory excavation material shall be transported to and placed in fill areas within the limits of the work. All unsatisfactory material and surplus material shall be removed from site . In the event that it is necessary to remove unsatisfactory material to a depth greater than specified, the Contracting Officer shall be notified. Excavations carried below the depths indicated, without specific directions, shall, except as otherwise specified, be refilled to the proper grade with satisfactory material as directed. All additional work of this nature shall be at the Contractor's expense. Excavation and filling shall be performed in a manner and sequence that will provide drainage at all times. Excavations shall be kept free from water.

3..3. DITCHES, GUTTERS, AND CHANNEL CHANGES

Ditches, gutters, and channel changes shall be cut accurately to the cross sections and grades indicated. Care shall be taken not to excavate ditches and gutters below the grades indicated. Excessive ditch and gutter excavation shall be backfilled to grade with satisfactory, thoroughly compacted material or with suitable stone or as directed. All ditches and gutters excavated under this section shall be maintained until final acceptance of the work. No excavated material shall be deposited closer to the edges of the ditches than indicated and in no case less than 3 feet.

3..4. BACKFILL ADJACENT TO STRUCTURES

Backfill adjacent to structures shall be placed and compacted uniformly in such manner as to prevent wedging action or eccentric loading upon or against the structures. Slopes bounding or within areas to be backfilled shall be stepped or serrated to prevent sliding of the fill. Backfill for storm drains and subdrains, including the bedding and backfill for structures other than culverts and drains, shall conform to the additional requirements in other applicable sections.

3..5. PREPARATION OF GROUND SURFACE FOR FILL

All vegetation, such as roots, brush, heavy sods, heavy growth of grass, and all decayed vegetable matter, rubbish, and other unsatisfactory material within the area upon which fill is to be placed, shall be removed before the fill is started. In no case will unsatisfactory material remain in or under the fill area. Sloped ground surfaces steeper than one vertical to four horizontal on which fill is to be placed shall be plowed, stepped, or broken up, as directed, in such manner that the fill material will bond with the existing surface. Prepared surfaces on which compacted fill is to be placed shall be wetted or dried as may be required to obtain the specified moisture content and density.

3..6. FILLS AND EMBANKMENTS

Fills and embankments shall be constructed at the locations and to lines and grades indicated. Stones having a dimension greater than 4 inches shall not be permitted in the upper 6 inches of fill or embankment. The material shall be placed in successive horizontal layers of 8 to 12 inches in loose depth for

the full width of the cross section and shall be compacted as specified. Each layer shall be compacted before the overlaying lift is placed. Moisture content of the fill or backfill material shall be adjusted as required, to within plus or minus 4 percent of optimum moisture content as determined from laboratory tests specified in paragraph DEFINITIONS.

3..7. COMPACTION

Except for paved areas, each layer of the fill or embankment shall be compacted to at least 90 percent of laboratory maximum density. Areas to be paved and other areas indicated as requiring compaction suitable for paved areas shall be compacted to a density of 95% laboratory maximum density for minimum compacted subgrade thickness as shown on the drawings.

3..8. FINISHED EXCAVATION, FILLS, AND EMBANKMENTS

All areas covered by the project shall be uniformly smooth-graded, compacted, and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from blade-grader operations, except as otherwise specified. Ditches and gutters shall be finished to permit adequate drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials. For subgrade areas to be paved, the following shall be accomplished as required: (a) soft or otherwise unsatisfactory material shall be replaced with satisfactory excavated material or other approved materials; (b) rock encountered in the cut sections shall be excavated to a depth of 6 inches below finished grade for the subgrade; (c) low areas resulting from removal of unsatisfactory material or from excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and shall be compacted as specified. The surface of embankments or excavated areas for road construction or other areas on which a base course or pavement is to be placed shall vary not more than 0.05 foot from the established grade and approved cross section. Surfaces other than those that are to be paved shall be finished not more than 0.15 foot above or below the established grade or approved cross section.

3..9. PLACING TOPSOIL

On areas to receive topsoil, the compacted subgrade soil shall be scarified to a 2 inch depth for bonding of topsoil with subsoil. Topsoil then shall be spread evenly to a thickness of 4 inches and graded to the elevations and slopes shown. Topsoil shall not be spread when frozen or excessively wet or dry. Material required for topsoil in excess of that produced by excavation within the grading limits shall be obtained from off-site areas.

3..10. NOT USED

3..11. \+*FIELD TESTING CONTROL*\+

Testing shall be the responsibility of the Contractor and shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Field density and moisture content tests shall be performed on every 5000 square feet of each lift placed. Field in-place density shall be determined in accordance with \-ASTM D 1556-\ or \-ASTM D 2167-\.

3..12. PROTECTION

Newly graded areas shall be protected from traffic and from erosion, and any settlement or washing away that may occur from any cause, prior to acceptance, shall be repaired and grades reestablished to the required elevations and slopes. All work shall be conducted in accordance with the environmental protection requirements of the contract.

SECTION 02222

EARTHWORK FOR UTILITIES SYSTEMS

SECTION 02222

EARTHWORK FOR UTILITIES SYSTEMS

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

\-ASTM D 422-\	(1963; R 1990) Particle-Size Analysis of Soils
\-ASTM D 1556-\	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
\-ASTM D 1557-\	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
\-ASTM D 2167-\	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
\-ASTM D 2487-\	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
\-ASTM D 2922-\	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

1..2. NOT USED

1..3. DEFINITIONS

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in \-ASTM D 1557-\.

1..4. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-09 Reports\

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

PART 2. PRODUCTS

2..1. SATISFACTORY MATERIALS

Satisfactory materials shall consist of any material classified by \-ASTM D 2487-\ as GW, GP, and SW.

2..2. UNSATISFACTORY MATERIALS

Unsatisfactory materials shall be materials that do not comply with the requirements for satisfactory materials. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris, frozen materials and stones larger than 3 inches, and materials classified in \-ASTM D 2487-\, as PT, OH, and OL.

2..3. COHESIONLESS AND COHESIVE MATERIALS

Cohesionless materials shall include materials classified in \-ASTM D 2487-\ as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

2..4. UNYIELDING MATERIAL

Unyielding material shall consist of rock and gravelly soils with stones greater than 3 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2..5. UNSTABLE MATERIAL

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

2..6. SELECT GRANULAR MATERIAL

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the l inch sieve. The maximum allowable aggregate size shall be 1 inch per foot of pipe diameter not to exceed 3 inches, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

2..7. INITIAL BACKFILL MATERIAL

Initial backfill shall consist of select granular material or satisfactory materials free from rocks 2 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller.

2..8. PLASTIC MARKING TAPE

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion.

Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

PART 3. EXECUTION

3..1. EXCAVATION

Excavation shall be performed to the lines and grades indicated. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench at least 1/2 the depth of the excavation, but no closer than 2 feet. The trench shall be excavated as recommended by the manufacturer of the pipe to be installed.

3..1..1. Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 3 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

3..1..2. Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed 4 inches below the required grade and replaced with suitable materials.

3..1..3. Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material compacted in lifts not exceeding 6 inches in loose thickness. When removal of unstable material is required due to the fault or neglect of the Contractor in his performance of the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

3..1..4. Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above.

When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

3..1..5. Jacking, Boring, and Tunneling

Unless otherwise indicated or approved, excavation shall be by open cut.

3..1..6. Stockpiles

Stockpiles of materials shall be placed and graded as specified or indicated. Stockpiles shall be kept in a neat and well drained condition. The ground surface at stockpile locations shall be cleared, grubbed, and sealed. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Government.

3..2. BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

3..2..1. Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall not be backfilled until all specified tests are performed.

3..2..1..1. Bedding and Initial Backfill

Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

3..2..1..2. Final Backfill

The remainder of the trench, except for special materials for roadways, railroads and airfields, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

a. Roadways, Railroads, and Airfields: Backfill shall be placed up to the elevation at which the requirements in Section \=02210=\ GRADING control. Water flooding or jetting methods of compaction will not be permitted.

b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 12 inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Water flooding or jetting methods of compaction will be permitted for granular noncohesive backfill material. Water jetting shall not be allowed to penetrate the initial backfill. Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

3..2..2. Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3..3. SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are:

3..3..1. NOT USED

3..3..2. NOT USED

3..3..3. NOT USED

3..3..4. Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated. Special trenching requirements for direct-burial electrical cables and conduits are specified in Section \=16375=\ ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

3..3..5. Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 18 inches below finished grade unless otherwise shown.

3..4. TESTING

3..4..1. Testing Facilities

Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the first inspection will be charged to the Contractor.

3..4..2. Testing of Backfill Materials

Characteristics of backfill materials shall be determined in accordance with particle size analysis of soils \-ASTM D 422-\ and moisture-density relations of soils \-ASTM D 1557-\. A minimum of one particle size analysis and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

3..4..3. \+Field Density Tests+

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 100 feet of installation shall be performed. One moisture density relationship shall be determined for every 1500 cubic yards of material used. Field in-place density shall be determined in accordance with \-ASTM D 1556-\, \-ASTM D 2167-\, or \-ASTM D 2922-\. Copies of field and laboratory density tests shall be furnished to the Contracting Officer within 24 hours of conclusion of the tests. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government.

3..4..4. Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to at least 2 feet above the top of the pipe, the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

SECTION 02243

DRAINAGE LAYER

SECTION 02243

DRAINAGE LAYER

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM C 29-\	(1991a) Unit Weight and Voids in Aggregate
\-ASTM C 88-\	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
\-ASTM C 117-\	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
\-ASTM C 131-\	(1989) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
\-ASTM C 136-\	(1995a) Sieve Analysis of Fine and Coarse Aggregates
\-ASTM D 75-\	(1987; R 1992) Sampling Aggregates
\-ASTM D 2487-\	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
\-ASTM D 2922-\	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
\-ASTM D 3017-\	(1988; R 1993) Water Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth)
\-ASTM D 4791-\	(1989) Flat or Elongated Particles in Coarse Aggregates
\-ASTM E 548-\	(1994) General Criteria Used for Evaluating Laboratory Competence

1..2. NOT USED

1..3. SYSTEM DESCRIPTION

The Contractor shall build a drainage layer under the pavements as indicated and in accordance with the following subparagraphs:

1..3..1. Aggregate Drainage Layer

A drainage layer consisting of rapid draining materials (RDM) or a combination of open graded materials (OGM) stabilized with choke stone meeting the gradations of Table I.

1..4. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-09 Reports\

Sampling and Testing\; *FIO*\.

Copies of field test results within 24 hours of completion of tests.

Approval of Materials\; *GA*\.

Material sources and material test results prior to field use.

Evaluation\; *GA*\.

Test section construction report.

1..5. FIELD COMPACTION

Field compaction requirements shall be based on the results of a test section constructed by the Contractor, using the materials, methods, and equipment proposed for use in the work. The test section shall meet the requirements of paragraph TEST SECTION.

1..6. EQUIPMENT

1..6..1. General Requirements

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times.

1..6..2. Placement Equipment

An asphalt paving machine shall be used to place drainage layer material. Alternate methods may be used if it can be demonstrated in the test section that these methods obtain the specified results.

1..6..3. Compaction Equipment

A dual or single smooth drum roller which provides a maximum compactive effort without crushing the drainage layer aggregate shall be used to compact drainage layer material.

1..7. WEATHER LIMITATION

Drainage layer material shall be placed when the atmospheric temperature is above 35 degrees F. Areas of completed drainage layer or underlying courses

that are damaged by freezing, rainfall, or other weather conditions or by contamination from sediments, dust, dirt, or foreign material shall be corrected by the Contractor to meet specified requirements.

1..8. *SAMPLING AND TESTING*

1..8..1. General Requirements

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory, or by the Contractor subject to approval. If the Contractor elects to establish testing facilities of his own, approval of such facilities shall be based on compliance with \-ASTM E 548-\, and no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved. The first inspection of the facilities will be at the expense of the Government and any subsequent inspections required because of failure of the first inspection shall be at the expense of the Contractor. Such costs will be deducted from the total amount due the Contractor. Drainage layer materials shall be tested to establish compliance with the specified requirements.

1..8..2. Sampling

Aggregate samples shall be taken in accordance with \-ASTM D 75-\.

1..8..3. Test Methods

1..8..3..1. \+Sieve Analyses+

Sieve analyses shall be made in accordance with \-ASTM C 117-\ and \-ASTM C 136-\.

1..8..3..2. \+Density Tests+

Field density tests shall be made in accordance with \-ASTM D 2922-\. When using this method, \-ASTM D 3017-\ shall be used to determine the moisture content of the aggregate drainage layer material. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in \-ASTM D 3017-\. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph "Calibration" of \-ASTM D 2922-\, on each different type of material being tested at the beginning of a job and at intervals as directed by the Contracting Officer.

1..8..3..3. \+Soundness Test+

Soundness tests shall be made in accordance with \-ASTM C 88-\.

1..8..3..4. \+Los Angeles Abrasion Test+

Los Angeles abrasion tests shall be made in accordance with \-ASTM C 131-\.

1..8..3..5. \+Flat or Elongated Particles Tests+

Flat and/or elongated particles tests shall be made in accordance with \-ASTM D 4791-\.

1..8..3..6. \+Fractured Faces Tests+

When aggregates are supplied from crushed gravel, approved test methods shall be used to assure the aggregate meets the requirements for fractured faces in paragraph AGGREGATES.

1..8..4. Testing Frequency

1..8..4..1. Aggregate Drainage Layer

Sieve analyses, field density, and moisture content tests shall be performed at a rate of at least one test for every 1000 square yards of completed area and not less than one test for each day's production. Soundness tests, Los Angeles abrasion tests, fractured faces tests and flat and/or elongated particles tests shall be performed at the rate of one test for every 10 sieve analysis tests.

1..8..5. *Approval of Materials*

1..8..5..1. Aggregate

The aggregate source shall be selected at least 60 days prior to field use in the test section. Tentative approval of the source will be based on certified test results to verify that materials proposed for use meet the contract requirements. Final approval of both the source and the material will be based on test section performance and tests for gradation, soundness, Los Angeles abrasion, flat and/or elongated particles tests and fractured faces tests. For aggregate drainage layer materials, these tests shall be performed on samples taken from the completed and compacted drainage layer course within the test section.

PART 2. PRODUCTS

2..1. NOT USED

2..2. AGGREGATES

Aggregates shall consist of clean, sound, hard, durable, angular particles of crushed stone, crushed slag, or crushed gravel which meet the specification requirements. Slag shall be an air-cooled, blast-furnace product having a dry weight of not less than 65 pcf determined by \-ASTM C 29-\. The aggregates shall be free of silt and clay as defined by \-ASTM D 2487-\, vegetable matter, and other objectionable materials or coatings.

2..2..1. Aggregate Quality

The aggregate shall have a soundness loss not greater than 18 percent weighted averaged at five cycles when tested in magnesium sulfate in accordance with \-ASTM C 88-\. The aggregate shall have a percentage of loss on abrasion not to exceed 40 after 500 revolutions as determined by \-ASTM C 131-\. The percentage of flat and/or elongated particles shall be determined by \-ASTM D 4791-\ with the following modifications. The aggregates shall be separated into two size fractions. Particles greater than 1/2 inch sieve and particles passing the 1/2 inch sieve and retained on the No. 4 sieve. The percentage of flat and/or elongated particles in either fraction shall not exceed 20. A flat particle is one having a ratio of width to thickness greater than 3; an

elongated particle is one having a ratio of length to width greater than 3. When the aggregate is supplied from more than one source, aggregate from each source shall meet the requirements set forth herein. When the aggregate is supplied from crushed gravel it shall be manufactured from gravel particles 90 percent of which by weight are retained on the maximum-size sieve listed in TABLE I. In the portion retained on each sieve specified, the crushed gravel shall contain at least 90 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the face. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces.

2..2..2. Gradation Requirements

Drainage layer aggregates shall be well graded within the limits specified in TABLE I.

TABLE I. GRADATION OF DRAINAGE LAYER MATERIAL

Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	Rapid Draining Material (RDM)
1-1/2 inch	100
1 inch	70-100
3/4 inch	55-100
1/2 inch	40-80
3/8 inch	30-65
No. 4	10-50
No. 8	0-25
No. 16	0-5

NOTE 1: Particles having diameters less than 0.02 mm shall not be in excess of 1.5 percent by weight of the total sample tested.

NOTE 2: The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves may require appropriate correction by the Contracting Officer when aggregates of varying specific gravities are used.

NOTE 3: For RDM, the coefficient of uniformity (CU) shall be greater than 3.5. (CU = D60/D10).

PART 3. EXECUTION

3..1. STOCKPILING AGGREGATES

Aggregates shall be stockpiled at locations designated by the Contracting Officer. Stockpile areas shall be cleared and leveled prior to stockpiling aggregates. All aggregates shall be stockpiled so as to prevent segregation and contamination. Aggregates obtained from different sources shall be stockpiled separately.

3..2. TEST SECTION

3..2..1. General

A test section shall be constructed to evaluate the ability to carry traffic and the constructability of the drainage layer including required mixing, placement, and compaction procedures. Test section data will be used by the Contracting Officer to determine the required number of passes and the field dry density requirements for full scale production.

3..2..2. Scheduling

The test section shall be constructed a minimum of 60 days prior to the start of full scale production to provide sufficient time for an evaluation of the proposed materials, equipment and procedures including Government QA testing.

3..2..3. Location and Size

The test section shall be placed outside the production paving limits in an area with similar subgrade and subbase conditions approved by the Contracting Officer. The underlying courses and subgrade preparation, required for the pavement section, shall be completed, inspected and approved in the test section prior to constructing the drainage layer. The test section shall be a minimum of 100 feet long and one full paving lane wide.

3..2..4. Initial Testing

Certified test results, to verify that the materials proposed for use in the test section meet the contract requirements, shall be provided by the Contractor and approved by the Contracting Officer prior to the start of the test section.

3..2..5. Mixing, Placement, and Compaction

Mixing, placement, and compaction shall be accomplished using equipment meeting the requirements of paragraph EQUIPMENT. Compaction equipment speed shall be no greater than 1.5 miles per hour.

3..2..6. Procedure

3..2..6..1. Aggregate Drainage Layer

The test section shall be constructed with aggregate in a moist state so as to establish a correlation between number of roller passes and dry density achievable during field production. Density and moisture content tests shall be conducted at the surface and at intervals of 2 inches of depth down for the total layer thickness, in accordance with \-ASTM D 2922-\ and \-ASTM D 3017-\. Sieve analysis tests shall be conducted on composite samples, taken adjacent to the density test locations, which represent the total layer thickness. One set of tests (i.e. density, moisture, and sieve analysis) shall be taken before compaction and after each subsequent compaction pass at three separate locations as directed by the Contracting Officer. Compaction passes and density readings shall continue until the difference between the average dry densities of any two consecutive passes is less than or equal to 0.5 pcf. The test section shall be completed by making one final pass with the roller in the static mode and observing any change in the drainage layer surface texture.

3..2..7. *Evaluation*

Within 10 days of completion of the test section, the Contractor shall submit to the Contracting Officer a Test Section Construction Report complete with all required test data and correlations. The Contracting Officer will evaluate the data and provide to the Contractor the required number of passes of the roller, the dry density for field density control during construction, the depth at which to check the density, and the need for a final static pass of the roller.

3..3. PREPARATION OF UNDERLYING COURSE

Prior to constructing the drainage layer, the underlying course shall be cleaned of all foreign materials. During construction, the underlying course shall contain no frozen material. Ruts or soft yielding spots in the underlying courses having inadequate compaction and deviations of the surface

from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line, and grade, and recompacting to specified density. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the drainage layer is placed.

3..4. TRANSPORTING MATERIAL

3..4..1. Aggregate Drainage Layer Material

Aggregate drainage layer material shall be transported to the site in a manner which prevents segregation and contamination of materials.

3..5. PLACING

3..5..1. General

Drainage layer material shall be placed on the underlying course in lifts of uniform thickness using equipment meeting the requirements of paragraph EQUIPMENT. When a compacted layer 6 inches or less in thickness is required, the material shall be placed in a single lift. When a compacted layer in excess of 6 inches is required, the material shall be placed in lifts of equal thickness. No lift shall exceed 6 inches or be less than 3 inches when compacted. The lifts shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the drainage layer is placed in more than one lift, the previously constructed lift shall be cleaned of loose and foreign material. Such adjustments in placing procedures or equipment shall be made to obtain true grades and minimize segregation and degradation of the drainage layer material.

3..5..2. NOT USED

3..5..3. NOT USED

3..5..4. Hand Spreading

In areas where machine spreading is impractical, drainage layer material shall be spread by hand. The material shall be spread uniformly in a loose layer so as to prevent segregation along with conforming to the required grade and thickness after compaction.

3..6. COMPACTION REQUIREMENTS

Compaction shall be accomplished using rollers meeting the requirements of paragraph EQUIPMENT and operating at a rolling speed of no greater than 1.5 miles per hour. Each lift of drainage material, including shoulders when specified under the shoulders, shall be compacted with the number of passes of the roller as specified by the Contracting Officer. In addition, a minimum field dry density, as specified by the Contracting Officer, shall be maintained. If the required field dry density is not obtained, the number of roller passes shall be adjusted in accordance with paragraph DEFICIENCIES. Excessive rolling resulting in crushing of aggregate particles shall be avoided. In all places not accessible to the rollers, the drainage layer material shall be compacted with mechanical hand operated tampers.

3..7. NOT USED

3..8. FINISHING

The top surface of the drainage layer shall be finished after final compaction as determined from the test section. Adjustments in rolling and finishing procedures shall be made to obtain grades and minimize segregation and degradation of the drainage layer material.

3..9. EDGES OF DRAINAGE LAYER

Shoulder material shall be placed along the edges of the drainage layer course in such quantity as will compact to the thickness of the layer being constructed. When the drainage layer is being constructed in two or more lifts, at least a one foot width of the shoulder shall be rolled and compacted simultaneously with the rolling and compacting of each lift of the drainage layer.

3..10. \+SMOOTHNESS TEST+

The surface of the top lift shall not deviate more than 3/8 inch when tested with a 10 12 foot straightedge applied parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding 3/8 inch shall be corrected in accordance with paragraph DEFICIENCIES.

3..11. THICKNESS CONTROL

The completed thickness of the drainage layer shall be within 1/2 inch of the thickness indicated. Thickness shall be measured at intervals providing at least one measurement for each 500 square yards of drainage layer. Measurements shall be made in test holes at least 3 inches in diameter. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected in accordance with paragraph DEFICIENCIES. Where the measured thickness is 1/2 inch more than indicated, it will be considered as conforming with the requirements plus 1/2 inch, provided the surface of the drainage layer is within 1/2 inch of established grade. The average job thickness shall be the average of all job measurements as specified above but within 1/4 inch of the thickness shown on the drawings.

3..12. DEFICIENCIES

3..12..1. Grade and Thickness

Deficiencies in grade and thickness shall be corrected such that both grade and thickness tolerances are met. In no case will thin layers of material be added to the top surface of the drainage layer to meet grade or increase thickness. If the elevation of the top of the drainage layer is more than 1/2 inch above the plan grade it shall be trimmed to grade and finished in accordance with paragraph FINISHING. If the elevation of the top surface of the drainage layer is 1/2 inch or more below the required grade, the surface of the drainage layer shall be scarified to a depth of at least 3 inches, new material shall be added, and the layer shall be blended and recompacted to bring it to grade. Where the measured thickness of the drainage layer is more than 1/2 inch deficient, such areas shall be corrected by excavating to the required depth and replaced with new material to obtain a compacted lift thickness of at least 3 inches. The depth of required excavation shall be

controlled to keep the final surface elevation within grade requirements and to preserve layer thicknesses of materials below the drainage layer.

3..12..2. Density

Density shall be considered deficient if the field dry density test results are below the dry density specified by the Contracting Officer. If the densities are deficient, the layer shall be rolled with 2 additional passes of the specified roller. If the dry density is still deficient, work will be stopped until the cause of the low dry densities can be determined by the Contracting Officer.

3..12..3. Smoothness

Deficiencies in smoothness shall be corrected as if they are deficiencies in grade or thickness. All tolerances for grade and thickness shall be maintained while correcting smoothness deficiencies.

SECTION 02275

GEOTEXTILE

SECTION 02275

GEOTEXTILE

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

The publications listed below form a part of the specification to the extent referenced. The publications are referenced in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 123	(1990) Standard Terminology Relating to Textile Materials
ASTM D 3786	(1987) Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphram Bursting Strength Tester Method
ASTM D 4355	(1984) Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	(1989) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1985) Trapezoidal Tearing Strength of Geotextiles
ASTM D 4632	(1986) Breaking Load and Elongation of Geotextiles (Grab Method)
ASTM D 4751	(1987) Determining the Apparent Opening Size of a Geotextile
ASTM D 4833	(1988) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation. Submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01300 SUBMITTAL PROCEDURES:

SD-01 Data\

Raw Materials\; *GA*\.

Manufacturer's certified material property data sheets.

SD-06 Instructions\

Tests, Inspections, and Verifications\; *GA*\

Manufacturer's quality control manual.

SD-14 Samples\

Tests, Inspections, and Verifications\; *GA*\

Geotextile sample.

1.4 DELIVERY, STORAGE AND HANDLING

Geotextiles shall be delivered only after the required submittals have been received and approved by the Contracting Officer. Geotextiles shall be kept dry at all times and shall be stored off the ground. Geotextiles shall be adequately protected from ultraviolet exposure, excessive heat, precipitation, contamination from dirt, debris, etc., or any other damaging circumstances. Geotextiles shall be marked or tagged with the following information: a) manufacturer's name, b) product identification, c) lot number, d) roll number, e) roll dimensions and f) date manufactured. Appropriate handling equipment and techniques, as recommended by the manufacturer and approved by the Contracting Officer, shall be used. Any geotextile damaged as a result of poor delivery, storage, or handling methods shall be repaired or replaced, as determined by the Contracting Officer, at no additional cost to the Government.

1.5 WARRANTY

Written warranties addressing geomembrane material and installation workmanship shall be submitted to and approved by the Contracting Officer. The manufacturer's warranty shall state that the installed material meets all requirements of the contract drawings and specifications that under typical local atmospheric conditions and weather aging, the sheet material is warranted for 20 years. The installer's warranty shall state that the geomembrane field and factory seams will not fail within 20 years of the installation under similar conditions.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General Requirements

The Contractor shall select a geotextile which meets all specification requirements and is chemically compatible with all contact materials.

2.1.2 Raw Materials

The geotextile shall be a non-woven pervious sheet of polymeric yarn as defined by ASTM D 123. The geotextile fiber shall consist of long-chain polymers composed of at least 85 percent by weight of polypropylene, polyester, polyethylene, nylon, or polyvinylidene-chloride. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration by ultra-violet and heat exposure. The

fabric shall be fixed so that the yarns will retain their relative position with respect to each other. The edges of the fabric shall be finished to prevent the outer yarn from pulling away from the fabric. The geotextile physical properties shall equal or exceed the minimum values listed in Table 1. Test values shown are minimum average roll values.

TABLE 1. GEOTEXTILE PHYSICAL PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE
AOS (U.S Sieve)	D 4751	70
Permittivity, sec^{-1}	D 4491	0.5
Mullen Burst, psi	D 3786	550
Puncture, lbs.	D 4833	165
Grab Tensile, lbs.	D 4632	235
Trapezoidal Tear, lbs.	D 4533	95
Ultraviolet Degradation @ 150 hours	D 4355	70% Strength Retained

2.2 *TESTS, INSPECTIONS, AND VERIFICATIONS*

2.2.1 Manufacturing Sampling and Testing

All geotextiles shall be randomly sampled and tested in accordance with the manufacturer's approved quality control program manual to evaluate the required physical properties. Certified test results on each sample shall be submitted to the Contracting Officer. In addition, one sample of each geotextile type shall be provided to the Government for quality assurance testing and permanent record of actual furnished material. Each sample shall be the full manufactured width of the geotextile by at least 5 feet (1525mm) long. Samples not meeting the minimum requirements specified shall result in the rejection of corresponding rolls.

2.2.2 Site Verification Sampling and Testing

2.2.2.1 Samples

The Contractor shall sample the geotextile immediately upon delivery to the project site. One of every 10 rolls of geotextile shall be sampled. The sampling procedure shall follow that given in the appropriate test method. Samples submitted for testing shall be identified by brand name, type of fabric, location and date manufactured, lot identification, length, and width. The samples shall be tested at an approved testing laboratory at the Contractor's expense.

2.2.2.2 Test Performance

The Contractor shall submit a report 30 days prior to geotextile field placement, stating the test results and certifying that all tests were performed in accordance with the procedures referenced in Table 1. If the

certified test results indicate values less than those specified, the roll from which the sample was obtained will be rejected and replaced with suitable material at no additional cost to the Government.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

The surface underlying the geotextile shall be prepared to a relatively smooth condition free of obstructions, depressions, debris, and soft or low density pockets of material. Erosion features (e.g. rills, gullies, etc.) shall be graded out of the surface before geotextile placement.

3.2 INSTALLATION

The Contractor shall round cut edges of existing floor plates such that no sharp areas exist which may damage the geotextile and overlying geomembrane. Reference drawings for additional information. The geotextile shall be placed with minimum handling such that the geotextile and underlying materials are not damaged. Any portion of the geotextile damaged during installation shall be removed or repaired, as determined by the Contracting Officer and as specified in paragraph: DEFECTS AND REPAIRS, at no additional cost to the Government. Where possible, the geotextile shall be placed with the machine direction oriented parallel to the slope direction and laid smooth so as to minimize tension, stress, folds, wrinkles, or creases. The geotextile shall be protected at all times during construction from contamination by surface runoff, dirt, mud, or any other foreign materials. Any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile at no additional cost to the Government. Adequate loading (e.g. sand bags) shall be placed on the geotextile to prevent uplift by wind. Any equipment used shall not damage the geotextile. No vehicular traffic will be allowed directly on the geotextile. The work shall be scheduled so that covering of the geotextile with the specified material is accomplished within 5 days after placement of the geotextile.

3.3 FIELD SEAMING

Geotextile panels shall be continuously overlapped a minimum of 12 inches (305mm). Where it is required that seams be oriented across the slope, the upper panel shall be lapped over the lower panel. Geotextile seams shall consist of two parallel rows of stitching. The two rows of stitching shall be 0.5 inches (13mm) apart with a tolerance of +/- 0.25 inches (6mm) and shall not cross, except the restitching. The stitching shall be a lock-type stitch and the thread shall meet the chemical compatibility requirements of the geotextile yarn. The minimum distance from the geotextile edge to the stitch line nearest to that edge shall be 1.5 inches (38mm) if a flat or prayer seam is used. The minimum distance for all other seam types shall be 1.0 inch (25mm). The seam, stitch type, and the equipment used to perform the stitching shall be as recommended by the geotextile manufacturer and as approved by the Contracting Officer. All seams shall be exposed with the seam up. The Contractor shall obtain a minimum of one destructive test sample per 1000 feet (305 meters) of field seam. Seam strengths shall be not less than 90 percent of the required tensile strength of the unaged geotextile in any principal direction when tested in accordance with ASTM D 4632. Certified test results on all field seams shall be submitted to and approved by the Contracting Officer prior to acceptance of the seam.

3.4 DEFECTS AND REPAIRS

Holes or tears in the geotextile shall be repaired by placing a patch of geotextile extending a minimum of 24 inches (610mm) beyond the edges of the hole or tear. All patches shall be continuously fastened by sewing or other methods recommended by the manufacturer and approved by the Contracting Officer. Excessively damaged geotextile, as determined by the Contracting Officer, shall be replaced at no additional cost to the Government.

3.5 PENETRATIONS

Geotextile penetration details shall be as recommended by the geotextile manufacturer, and as approved by the Contracting Officer.

SECTION 02277

GEOMEMBRANE BARRIER

SECTION 02277

GEOMEMBRANE BARRIER

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

The publications listed below form a part of the specification to the extent referenced. The publications are referenced in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 638	(1989) Test Method for Tensile Properties of Plastics
ASTM D 746	(1987) Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 751	(1989) Standard Methods of Testing Coated Fabrics
ASTM D 1004	(1988) Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1593	(1989) Specification for Nonrigid Vinyl Chloride Plastic Sheeting
ASTM D 1693	(1988) Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 4437	(1988) Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D 4833	(1988) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 5321	(1993) Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

NATIONAL SANITATION FOUNDATION (NSF)

NSF Standard 54	(1991) Standard for Flexible Membrane Liners GEOSYNTHETIC RESEARCH INSTITUTE (GRI)

1.2 **APPLICABILITY**

This specification covers placement of a high density polyethylene (HDPE) geomembrane within secondary containment areas.

1.3 DEFINITIONS

1.3.1 Installer

The person or corporation hired by the Contractor who is responsible for field handling, deploying, seaming, anchoring, and field Quality Control (QC) testing of the geomembrane panels/sheets.

1.3.2 Inspector

The third party Quality Assurance (QA) Person or corporation hired by the Contractor, independent from the manufacturer, fabricator, and installer, who is responsible for monitoring and documenting activities related to the quality assurance of the geomembrane from manufacturing through installation.

1.3.3 Independent Laboratory

The third party QA lab hired by the Contractor, independent from the manufacturer, fabricator, and installer who is responsible for laboratory quality assurance geomembrane testing.

1.3.4 Sheet

A manufactured seamless geomembrane unit with a width equal to or greater than 5 feet (1524mm).

1.3.5 Panel

A factory or field fabricated geomembrane unit composed of several geomembrane sheets seamed together.

1.3.6 Film Tearing Bond (FTB)

A failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area.

1.4 QUALIFICATIONS

1.4.1 Manufacturer

Manufacturer shall have produced the proposed geomembrane sheets for at least five completed projects totalling a minimum of two million square feet (185806.1 square meters). A name and telephone number of a facility contact for each project shall be provided.

1.4.2 Installer

Installer shall have installed the proposed geomembrane material for at least five completed projects totalling a minimum of two million square feet (185806.1 square meters). A name and telephone number of a facility contact for each project shall be provided. At least one seamer shall have seaming experience seaming a minimum of 500,000 square feet (46451.52 square meters) of the proposed geomembrane using the same type of seaming equipment and geomembrane mil thickness specified for this project. All other personnel performing seaming operations shall be qualified by similar experience or will be required to pass a seaming test in accordance with paragraph: TEST SEAMS.

1.4.3 Inspector

Inspector shall have provided QA inspection during manufacturing, fabrication, and installation of the proposed geomembrane material for at least five completed projects totalling a minimum of two million square feet (185806.1 square meters). A name and telephone number of a facility contact for each project shall be provided.

1.4.4 Independent Laboratory

Independent laboratory shall have provided QC and/or QA testing of the proposed geomembrane seams for at least five completed projects totalling a minimum of two million square feet (185806.1 square meters). A name and telephone number of a facility contact for each project shall be provided.

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation, submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01300 SUBMITTAL PROCEDURES:

SD-01 Data\

Materials\; *GA1*\.

Manufacturer's certified raw material and sheet material data sheets.

SD-04 Drawings\

Shop Drawings\; *GA1*\

Shop drawings for FML installation including anchorage and penetration details, and FML layout plan.

As-built Drawings\; *GA1*\

Final as-built drawings of geomembrane installation.

SD-06 Instructions\

Tests, Inspections, and Verifications\; *GA1*\

Manufacturer's quality control manual.

Field Seaming\; *GA1*\

Installer's quality control manual.

SD-08 Statements\

Qualifications\; *GA1*\

Manufacturer's, installer's, inspector's, and independent laboratory's qualification statements including resumes of key personnel involved in this project.

SD-09 Reports\

Tests, Inspections, and Verifications\; *GA*\.

Manufacturer's certified quality control test results.

Field Seaming\; *GA*\

Installer's certified quality control test results.

SD-14 Samples\

Tests, Inspections, and Verifications\; *GA1*\

One 12 inch (305mm) by 12 inch (305mm) minimum size sheet sample.

One 12 inch (305mm) by 12 inch (305mm) minimum size sample of each type of proposed field seam.

1.6 DELIVERY, STORAGE AND HANDLING

Geomembrane materials shall be delivered only after the required submittals have been received and approved by the Contracting Officer. No off-loading shall be done unless the Inspector is present. The geomembrane shall be adequately protected at all times from puncture, abrasion, excessive heat or cold, degradation of the material, adhesion of individual layers or other damaging circumstances. Any geomembrane damaged as a result of poor delivery, storage, or handling methods shall be replaced at no additional cost to the Government.

1.7 WEATHER LIMITATIONS

Geomembrane deployment and field seaming shall not be done during any precipitation, in the presence of excessive moisture (e.g fog, dew, standing water), or during high winds. Where weather conditions are marginal for seaming, as determined by the Inspector, test seams, as described in paragraph TEST SEAMS shall be made with the Inspector present to decide if production seaming can proceed.

1.8 WARRANTY

Written warranties addressing geomembrane material and installation workmanship shall be submitted to and approved by the Contracting Officer. The manufacturer's warranty shall state that the installed material meets all requirements of the contract drawings and specifications that under typical local atmospheric conditions and weather aging, the sheet material is warranted for 20 years. The installer's warranty shall state that the geomembrane field and factory seams will not fail within 20 years of the installation under similar conditions.

1.9 EQUIPMENT

All equipment used in performance of the work shall be approved by the Contracting Officer prior to commencement of work. This equipment shall be maintained in satisfactory working condition at all times.

1.10 AS-BUILT DRAWINGS

The Installer shall provide final as-built drawings showing panel/sheet numbers, seam numbers, and the location of patches, destructive seam samples, and penetrations.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 General Requirements

The Contractor shall select a non-reinforced geomembrane which meets all specification requirements.

2.1.2 Raw Materials

The materials used to manufacture geomembrane sheets shall be 100% domestic, first-quality raw materials, using no more than 2% recycled ingredients that originate from the same formulation and the same production lot and which are clean and free of any foreign contaminants. HDPE resin shall have a minimum density of 0.940 g/cc. The manufacturer shall provide certification that the raw materials meet or exceed these requirements along with a copy of the quality control certificates.

2.1.3 Sheet Material

All sheets and factory seams shall conform to the minimum physical requirements listed in NSF STANDARD 54 for the appropriate material and Table 1 as follows. Test values shown in Table 1, except when specified as minimum or maximum, are typical test values. For materials not included in NSF STANDARD 54, manufacturer's property specifications shall be substituted. In all cases, manufacturer's property specifications shall be submitted to and approved by the Contracting Officer a minimum of 30 days prior to delivery to the site.

TABLE 1. GEOMEMBRANE PHYSICAL PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE
		HDPE
Thickness, mils, (nominal)	----------	60
Thickness, mils, (minimum)	ASTM D 1593	60
Tensile Strength at Break, lbs/inch (grams/cm.) width	ASTM D 638	180 (32144.34)
Elongation at Break, (%)	ASTM D 638	500
Tear Resistance, lbs. (Kg)	ASTM D 1004, Die C	30 (13.61)
Puncture Resistance, lbs. (N)	ASTM D 4833	52 (231.3)

Environmental Stress Crack, hours, (minimum)	ASTM D 1693	1500
Low Temperature Brittleness, degrees F	ASTM D 746	-40
Seam Shear Strength, lbs/inch (grams/cm) width, (minimum)	ASTM D 5321 ASTM D 4437	108 (19286.6) or 12" (305mm) elong.
Seam Peel Adhesion, lbs/inch (grams/cm) width, (minimum)	ASTM D 4437	85 (15179.27) and FTB

Sheets shall be non-reinforced and uniform in color, thickness, and surface texture.

Sheets shall be free of and resistant to fungal or bacterial attack.

No fatty acid residues, epoxy or secondary plasticizers shall be used.

Sheets shall be free of cuts, abrasions, holes, blisters, contaminants and other imperfections.

Sheets shall be manufactured in as wide a width as possible to minimize field seams and shall be produced in the United States.

All seams shall meet the minimum shear and peel strength requirements shown in Table 1.

2.2 *TESTS, INSPECTIONS, AND VERIFICATIONS*

2.2.1 Manufacturing Sampling and Testing

Geomembrane sheets shall be randomly sampled and tested in accordance with the manufacturer's approved QC manual. Certified test results on each sample shall be submitted to the Contracting Officer. One 12 inch (305mm) by 12 inch (305mm) minimum size geomembrane sample, along with appropriate identification, shall be provided to the Government for quality assurance testing and permanent record of actual furnished material. Samples not meeting the minimum requirements specified shall result in the rejection of the applicable sheets.

2.2.1.1 Resin Materials

Resin shall be tested in accordance with the approved geomembrane manufacturer's QC manual and certified test results submitted to the Contracting Officer. Any resin which fails to meet the geomembrane manufacturer's specified physical properties shall not be accepted for manufacturing the sheet. Polyethylene seaming rod and/or pellets shall be manufactured of resin which is essentially identical to that used in the geomembrane sheet. Seaming rod and/or pellets shall be tested for density, melt index and carbon black content in accordance with the approved geomembrane manufacturer's QC manual and certified test results submitted to the Contracting Officer. Any seaming rod and/or pellets which fail to meet the corresponding property values required for the sheet material, shall be rejected.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Surface Preparation

Prior to placement of the liner, the surface shall be prepared as specified in SECTIONS GRADING & GEOTEXTILE. Final approval of all subgrades shall be made by the Contracting Officer.

3.2 PANEL/SHEET DEPLOYMENT

The geomembrane shall be placed with minimum handling. Any portion of geomembrane damaged during installation shall be removed or repaired, at the Inspector's discretion and as specified in paragraph DEFECTS AND REPAIRS, at no additional cost to the Government.

Only those panels/sheets that can be anchored/ballasted and seamed together the same day shall be deployed.

All procedures and equipment used shall not damage the geomembrane. No vehicular traffic will be allowed directly on the geomembrane.

All personnel working on the geomembrane shall not smoke or wear shoes that could puncture or otherwise damage the geomembrane.

The method used to place the panels/sheets shall not scratch, crimp or excessively elongate the geomembrane and shall not detrimentally rut the subgrade soil as determined by the Inspector.

The method used to place the panels/sheets shall minimize wrinkles. However, the geomembrane manufacturer and installer shall coordinate efforts to provide the proper amount of slack in the deployed geomembrane so as to compensate for contraction due to local temperature extremes.

Adequate ballast (e.g., sand bags) shall be placed on the geomembrane to prevent uplift by wind without damaging the geomembrane.

A minimum of two thickness readings shall be taken along the edge across each panel/sheet width and at least four thickness measurements shall be taken along each panel/sheet length in accordance with ASTM D 751. A minimum of two additional readings shall be taken across the width at any point where the panel/sheet has been cut. Panels/sheets whose mil thickness falls below the specified minimum value shall be rejected and replaced at no additional cost to the Government.

3.3 FIELD SEAMING

3.3.1 Test Seams

Test seams shall be made on test strips of geomembrane to verify that seaming conditions are adequate. They shall be made at a location selected by the Inspector in the area to be seamed and in contact with the subgrade. Test seams shall be made each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment, and at least once every four hours by each seamer and seaming equipment used that day. One sample shall be

obtained from each test seam. This sample shall be at least 36 inches (914mm) long by 20 inches (508mm) wide with the seam centered lengthwise. Ten random specimens 1 inch (25mm) wide shall be cut from the sample. The Installer shall field test 5 seam specimens for shear strength and 5 seam specimens for peel adhesion using an approved quantitative tensiometer. Jaw separation speed shall be 2 inches (50mm) per minute. To be acceptable, four out of five replicate test specimens must meet specified seam strength requirements. If the field tests fail to meet these requirements, the entire operation shall be repeated. If the additional test seam fails, the seaming apparatus or seamer shall not be accepted or used for seaming until the deficiencies are corrected by the Installer and two consecutive successful test seams are achieved.

3.3.2 Field Seams

3.3.2.1 General Requirements

All panels/sheets shall be overlapped a minimum of 3 inches (76mm).

Seams shall be oriented parallel to the line of maximum slope and with the fewest possible number of wrinkles. Where seams can only be oriented across the slope, the upper panel shall be lapped over the lower panel.

In corners and odd-shaped geometric locations, the number of field seams shall be minimized.

Seaming shall extend to the outside edge of panels/sheets to be placed in anchor and/or drainage trenches.

Seaming shall not be conducted in the presence of standing water and/or soft subgrades as determined by the Inspector. All wet surfaces shall be thoroughly dried and all soft subgrades compacted and approved by the Installer, Inspector and Contracting Officer prior to seaming. The seam area shall be cleaned of all dust, dirt, and foreign material prior to and during seaming.

3.3.2.2 Seams

All geomembranes shall be seamed by hot wedge methods. Extrusion welding shall only be allowed for patching and seaming around appurtenances.

If seam overlap grinding is required, the procedure used shall not damage the geomembrane. Grinding marks shall be oriented perpendicular to the seam direction and no marks shall appear beyond 1/8 inch (3mm) of the extrudate after placement. The depth of the grinding marks shall be no greater than 10% of the sheet thickness.

Where extrusion fillet welds are temporarily terminated long enough to cool, they shall be ground prior to applying new extrudate over the existing seam.

3.3.3 Field Sampling and Testing

3.3.3.1 Non-destructive Field Seam Testing

All field seams shall be non-destructively tested over their full length using test equipment and procedures described in the Installer's QC manual as

approved by the Inspector and Contracting Officer. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming. Any seams which fail shall be documented and repaired in accordance with paragraph: DEFECTS AND REPAIRS.

3.3.3.2 Destructive Field Seam Testing

A minimum of one destructive test sample per 500 feet (152 meters) of field seam length shall be obtained at locations specified by the Inspector. Sample locations shall not be identified prior to seaming. The samples shall be a minimum of 12 inches (305mm) wide by 48 inches (1220 mm) long with the seam centered lengthwise. Each sample shall be cut into three equal pieces with one piece retained by the Installer, one piece given to the Independent Laboratory, and the remaining piece given to the Contracting Officer for quality assurance testing and permanent record. Each sample shall be numbered and cross referenced to a field log which identifies: (1) panel/sheet number; (2) seam number; (3) top sheet; (4) date and time cut; (5) ambient temperature; (6) seaming unit designation; (7) name of seamer; and (8) seaming apparatus temperature and pressures (where applicable). A minimum of four 1-inch (25mm) wide replicate specimens shall be cut from the Installer's sample. A minimum of 2 specimens shall be tested for shear strength and 2 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be 2 inches (50mm) per minute. Both tracks of a double wedge seam shall be tested for peel adhesion. To be acceptable, all replicate test specimens must meet the specified seam strength requirements. If the field tests pass, 5 specimens shall be tested at the Independent Laboratory for shear strength and 5 for peel adhesion in accordance with ASTM D 4437. Both tracks of a double wedge seam shall be tested for peel adhesion. To be acceptable, 4 out of 5 replicate test specimens must meet specified seam strength requirements. If the field or laboratory tests fail, the seam shall be repaired in accordance with paragraph REPAIR PROCEDURES. In addition, all destructive seam sample holes shall be repaired the same day as cut. Certified test results on all field seams shall be submitted to and approved by the Contracting Officer prior to acceptance of the seam.

3.3.4 Defects and Repairs.

3.3.4.1 Identification

Immediately prior to covering the geomembrane, all seams and non-seam areas shall be visually inspected by the Inspector and Contracting Officer for defects, holes, or damage due to detrimental weather conditions or construction activities. At the Contracting Officer's discretion, the surface of the geomembrane shall be brushed, blown, or washed by the Installer if the amount of dust, mud, or other foreign material inhibits inspection or functioning of the overlying material.

3.3.4.2 Evaluation

At the Contracting Officer's discretion, each suspect location shall be non-destructively tested using methods approved by the Contracting Officer. Each location that fails non-destructive testing shall be repaired and re-tested by the Installer until it passes. Final acceptance of all seam and non-seam areas will be made by the Contracting Officer.

3.3.4.3 Repair Procedures

For defective seams, the defective area may be overlaid with a strip of new material and seamed (cap stripped). Alternatively, the seaming path shall be retraced to an intermediate location 10 feet (at 3048mm) minimum each side of the failed seam location). At each location a 12 inch (305mm) by 12 inch (305mm minimum size seam sample shall be taken for 2 additional shear strength and 2 additional peel adhesion tests using an approved quantitative field tensiometer. If these field tests pass, then the remaining seam sample portion shall be sent to the Independent Laboratory for 2 shear strength and 2 peel adhesion tests in accordance with ASTM D 4437. If these laboratory tests pass, then the seam shall be cap stripped between that location and the original failed location. If field or laboratory tests fail, then the process is repeated. After cap stripping, the entire cap stripped seam shall be non-destructively tested using methods approved by the Contracting Officer. Certified test results on all repaired seams shall be submitted to and approved by the Contracting Officer prior to covering the seamed areas. Tears, holes, blisters and areas with undispersed raw materials or foreign material contamination shall be repaired by patches. Patches shall have rounded corners, be made of the same geomembrane, and extend a minimum of 6 inches (152mm) beyond the edge of defects. Minor localized flaws shall be repaired by spot welding or seaming as determined by the Inspector. All repairs shall be non-destructively tested using methods approved by the Contracting Officer. The Inspector may also elect to perform a destructive seam test on a suspect area.

3.4 PENETRATIONS

Geomembrane penetration details shall be as recommended by the geomembrane manufacturer, fabricator or installer, and as approved by the Contracting Officer. Factory fabricated boots shall be used wherever possible. All tailored area field seams shall be non-destructively tested.

SECTION 02540

CONCRETE PAVEMENT, BASE COURSES,
AND STRAIGHT CURB

SECTION 02540

CONCRETE PAVEMENT, BASE COURSES,
AND STAIGHT CURB

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referred. The publications are referred to in the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

\-AASHTO T 193-\	(1993) Standard Method of Test for the California Bearing Ratio

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 185-\	(1994) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
\-ASTM A 499-\	(1989) Steel Bars and Shapes, Carbon Rolled from "T" Rails
\-ASTM A 615-\	(1995c) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
\-ASTM A 616-\	(1996) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
\-ASTM A 617-\	(1996) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
\-ASTM A 675-\	(1990a) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
\-ASTM C 33-\	(1993) Concrete Aggregates
\-ASTM C 39-\	(1994) Compressive Strength of Cylindrical Concrete Specimens
\-ASTM C 78-\	(1994) Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
\-ASTM C 94-\	(1996) Ready-Mixed Concrete
\-ASTM C 143-\	(1990a) Slump of Hydraulic Cement Concrete
\-ASTM C 150-\	(1995a) Portland Cement
\-ASTM C 227-\	(1990) Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)

\-ASTM C 260-\	(1995) Air Entraining Admixtures for Concrete
\-ASTM C 309-\	(1995) Liquid Membrane-Forming Compounds For Curing Concrete
\-ASTM C 311-\	(1996a) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
\-ASTM C 494-\	(1992) Chemical Admixtures for Concrete
\-ASTM C 618-\	(1996) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
\-ASTM C 666-\	(1992) Resistance of Concrete to Rapid Freezing and Thawing
\-ASTM C 881-\	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
\-ASTM D 1556-\	(1990) Density and Unit Weight of Soil In-Place by the Sand-Cone Method
\-ASTM D 1557-\	(1991) Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m))
\-ASTM D 1751-\	(1983 -R-91) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
\-ASTM D 1752-\	(1984 -R-92) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

FEDERAL SPECIFICATIONS (FS)

\-FS SS-S-200-\	(Rev F; N-2) Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

STATE HIGHWAY SPECIFICATION (SHS)

STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES, North Carolina Deptment of Transportation, 1990 edition

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data\

Epoxy Resin\; *FIO*\

Admixtures\; *FIO*\

Curing Materials\; *FIO*\

Cement\; *FIO*\

Fly Ash\; *FIO*\

Joint Filler\; *FIO*\

Separating and Blocking Media\; *FIO*\

Concrete Mix Design\; *GA*\

Concrete Aggregates\; *GA*\

Reinforcement\; *FIO*\

Joint Sealant\; *FIO*\

SD-09 Reports\

Concrete Field Tests\; *GA*\)

Tests\; *GA*\

PART 2 PRODUCTS

2.1 PORTLAND CEMENT CONCRETE PAVEMENT

The Contractor shall submit a portland cement *concrete mix design*\ showing that the mix and materials comply with the requirements specified in Section 700 Portland Cement Concrete Pavement of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply. Portland cement concrete shall have a minimum compressive strength of 4,000 psi or a minimum flexural strength of 650 psi at 28 days. Test cylinders or beams shall be tested in conformance with \-ASTM C 39-\ for compressive and \-ASTM C 78-\ for flexural strength. Concrete shall not have a slump exceeding 2 inches for fixed form paving and 1-1/2 inches for slip form paving. The air content of the concrete by volume shall be maintained by the contractor at 6.0 percent plus or minus 1.0 percent and the maximum water/cement ratio shall be 0.45.

2.1.1 *CEMENT*

Cement shall be portland cement. Portland cement shall conform to \-ASTM C 150-\, type I or II. The cement shall meet the requirements for low alkali and for false set contained therein. If the Contractor can satisfactorily demonstrate that the proposed composition of cement and aggregate to be used in the concrete mix is nonreactive when tested in accordance with \-ASTM C 227-\, the low alkali requirement may be waived. Certified test results and supporting test data for determining nonreactivity must be submitted for approval and no substitutions shall be permitted in the aggregate and cement used in the work without additional testing. Cement shall also conform to the

requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.1.2 *FLY ASH*

Fly ash shall conform to the requirements of \-ASTM C 618-\, class F or C, including the Supplementary Optional Chemical Requirement for available alkalies and the Supplementary Optional Physical Requirements for uniformity and reactivity with cement alkalies. Maximum loss on ignition shall not be over 4 percent. Samples shall be obtained, prepared, and tested in accordance with \-ASTM C 311-\. Only one class of fly ash from a single source may be used. Fly ash shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.1.3 *CONCRETE AGGREGATES*

Aggregate shall conform to \-ASTM C 33-\, except Procedure A of \-ASTM C 666-\ shall be used for fine aggregate requiring freezing and thawing tests. Aggregate shall have a maximum nominal size of 1.5 inches. Coarse aggregate shall have a service record of at least 5 years successful service in three paving projects. The aggregates shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.1.4 *ADMIXTURES*

Air-entraining admixture shall conform to \-ASTM C 260-\. Accelerating admixture shall conform to \-ASTM C 494-\, Type C, and shall be used only when cold weather protection is required and the Contractor requested its use in writing and has received written approval. Water-reducing or retarding admixtures shall conform to \-ASTM C 494-\, Type A, B, or D. The admixtures shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.1.5 *CURING MATERIALS*

Curing materials shall be an approved white pigmented membrane-forming curing compound conforming to the requirements specified in \-ASTM C 309-\, Type 2, Class A or B. Curing materials shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.1.6 *JOINT FILLER*

For Expansion Joints and Thickened Edge Slip Joints. Filler shall be a preformed material conforming to \-ASTM D 1751-\ or \-ASTM D 1752-\. Joint filler shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.1.7 *EPOXY RESIN*

All epoxy resin materials shall be two-component materials conforming to the requirements of \-ASTM C 881-\, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall

meet the following requirements: All materials shall have a 24 hour absorption not greater than 1.0 percent. Epoxy resin materials for use for embedding dowels shall be Type III materials and shall in addition meet the following requirements:

The bond strength at 14 days (moist cure) shall be at least 1000 psi.
The volatile content, cured system, shall not exceed 3.0 percent.
Grade 3 shall be used for embedding dowels in hardened concrete.

The epoxy resin shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.1.8 *SEPARATING AND BLOCKING MEDIA*

Separating and blocking media shall be readily compressible, nonshrinkable, nonreactive with the sealant, and nonabsorptive, such as extruded butyl or polychloroprene foam rubber. It shall not melt or soften at pouring temperature of the sealant. The separating and blocking media shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.1.9 *JOINT SEALANT*

Jet-Fuel-Resistant joint sealer for concrete pavement shall be cold-applied conforming to \-FS SS-S-200-\. The joint sealant shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.1.10 *REINFORCEMENT*\ STEEL

Tie bars shall be deformed steel bars conforming to \-ASTM A 615-\, \-ASTM A 616-\ or \-ASTM A 617-\ and of the sizes and dimensions indicated. Wire mesh reinforcement shall conform to \-ASTM A 185-\. Dowels shall be one-piece, smooth steel bars conforming to \-ASTM A 675-\, Grade 80; \-ASTM A 615-\, Grade 40 or 60; or to \-ASTM A 499-\, and shall be of the size indicated. The reinforcement steel shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

2.2 CONCRETE STRAIGHT CURB

Portland cement concrete straight curb shall conform to and be placed in accordance with the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply. Concrete shall have a minimum compressive strength of 4000psi at 28 days. Test cylinders shall be tested in conformance with \-ASTM C 39-\. Mixtures shall have air content by volume of concrete of 4 to 8 percent, based on measurements made immediately after discharge from the mixer. The concrete slump shall be no greater than 4 inches where determined in accordance with \-ASTM C 143-\. Tests shall be as necessary to demonstrate complete compliance with the requirements of the SHS, and as specified herein.

2.3 BASE COURSES

2.3.1 CRUSHED AGGREGATE BASE COURSE

Aggregate Base Course shall conform to the requirements specified in Section 520 Aggregate Base Course" type A of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply. The aggregate shall have a minimum California Bearing Ratio (CBR) of 80. The CBR shall be determined in accordance with \-AASHTO T 193-\. Testing shall be as necessary to demonstrate complete compliance with the requirements of the SHS, and as specified herein. At least one complete series of aggregate tests shall be performed prior to the start of construction.

2.3.2 DRAINAGE LAYER

Drainage Layer shall conform to the requirements in SECTION 02243: DRAINAGE LAYER.

PART 3 EXECUTION

3.1 PAVEMENT REMOVAL

Where pavement is to be removed at the locations shown on the drawings, the pavement shall be sawed with an approved concrete saw prior to removal so as to leave a straight, true, edge. The pavement material and underlying courses shall be removed in a manner that will not disturb the adjacent in-place material. Pavements or base courses not identified for removal that are damaged shall be replaced and compacted at no additional cost to the Government. Pavement material from the removal area shall be disposed of off Government controlled land at the Contractor's expense. Pavement removal shall also conform to the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply.

3.2 PAVEMENT CONSTRUCTION

New pavement or replacement pavement construction shall consist of the construction of new pavement including all base courses as specified in Part 2.

3.2.1 BASE COURSES

3.2.1.1 CRUSHED AGGREGATE BASE COURSE

Aggregate base course shall be placed in accordance with Section 520 Aggregate Base Course".

3.2.2 PORTLAND CEMENT CONCRETE PAVEMENT

Portland cement concrete pavement shall be placed in accordance with Section 700 "Portland Cement Concrete Pavement". The final surface texture shall be a burlap drag finish. Paragraphs: "Method of Measurement" and "Basis of Payment" of the SHS shall not apply.

3.2.3 CONCRETE STRAIGHT CURB

Portland cement concrete straight curb shall conform to and be placed in accordance with the requirements of the SHS, except as modified herein. Paragraphs: "Method of Measurement" and "Basis of Payment" shall not apply. Concrete straight curb shall be constructed to the dimensions shown on the

drawings. Replacement straight curb shall match existing straight curb or as directed by the contracting officer.]]

3.3 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor performed at no additional cost to the Government in accordance with SECTION \=01440=\ CONTRACTOR QUALITY CONTROL and as specified herein. Sampling and testing shall be performed by an approved testing laboratory and shall be in accordance with the following and the SHS. Costs incurred for subsequent inspection, and, or replacement of materials for nonconformance shall be at the Contractor's expense. No extension of time shall be given to the Contractor for retesting or replacement of materials for nonconformance. The Contractor shall submit for approval, the test results as specified in paragraph: SUBMITTALS, at least 30 days prior to commencing construction. At least one complete series of aggregate *tests*\ shall be performed prior to the start of construction to demonstrate complete compliance with the requirements of the SHS.

3.3.1 CONCRETE PAVEMENT

3.3.1.1 *CONCRETE FIELD TESTS*\

Except as modified hereinafter, tests to determine the slump, air content, and strength of the concrete shall be performed by the Contractor in accordance with the requirements of \-ASTM C 94-\. Tests for slump and air content shall be made each time specimens are fabricated and at such other times as directed by the Contracting Officer. Compressive strength tests shall be executed as stated by the SHS. Flexural test beams shall be taken not less than once a day nor less than once for each 250 cubic yards cubic yards of concrete or fraction thereof. Beams shall be tested in accordance with \-ASTM C 78-\ by an approved testing laboratory at no cost to the Government. Sufficient specimens shall be molded each time to provide two compressive or flexural strength tests at each test age of 7, 14, and 28 days.

3.3.2 CONCRETE STRAIGHT CURB

3.3.2.1 *CONCRETE FIELD TESTS*\

Except as modified hereinafter, tests to determine the slump, air content, and strength of the concrete shall be performed by the Contractor in accordance with the requirements of \-ASTM C 94-\. Tests for slump and air content shall be made each time specimens are fabricated and at such other times as directed by the Contracting Officer. Compressive strength tests shall be executed as stated by the SHS. Sufficient specimens shall be molded each time to provide two compressive strength tests at each test age of 7, 14, and 28 days.

3.3.3 AGGREGATE BASES

3.3.3.1 COMPACTION

Laboratory maximum density of aggregate bases shall be determined in accordance with \-ASTM D 1557-\. Density shall be measured in the field in accordance with \-ASTM D 1556-\. The aggregate bases shall be compacted to at least 100 percent of laboratory maximum density.

3.3.3.2 TESTING FREQUENCY

3.3.3.2.1 INITIAL *TESTS*

One of each of the following tests shall be performed by the contractor on the proposed material prior to commencing construction to demonstrate that the proposed material will meet all specified requirements when furnished and after placing and compaction.

Sieve Analysis (Including 0.02 mm)
L.A. Abrasion
Soundness
Liquid-Limit and Plasticity-Index
Moisture-Density Relationship

3.3.3.2.2 IN-PLACE *TESTS*

One of each of the following tests shall be performed on samples taken from the placed and compacted base course. Samples shall be taken for each 1000 square yards, or fraction thereof, for each layer placed in each area.

Sieve Analysis (Including 0.02 mm)
Field Density and Moisture
Liquid-Limit and Plasticity-Index

3.3.3.3 THICKNESS OF AGGREGATE BASES

The Contractor shall control his operations by measurements to insure placement of materials to the thickness specified. Thickness of each aggregate base course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square yards or part thereof of aggregate course. Measurements shall be made in 3-inch diameter test holes penetrating each base course. Measurements may be made by the Government for verification of compliance; however, the Contractor shall not depend on such measurements for his control of operations.

SECTION 02710

SUBDRAINAGE SYSTEM

SECTION 02710

SUBDRAINAGE SYSTEM

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM D 1784-\	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
\-ASTM F 758-\	(1993) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

1..2. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-13 Certificates\

Pipe for Subdrains\; *FIO*\.

1..3. DELIVER, STORAGE, AND HANDLING

1..3..1. Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with minimum handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. During shipment and storage, geotextile shall be wrapped in burlap or similar heavy duty protective covering. The storage area shall protect the geotextile from mud, soil, dust, and debris. Geotextile materials that are not to be installed immediately shall not be stored in direct sunlight. Plastic pipe shall be installed within 6 months from the date of manufacture unless otherwise approved.

1..3..2. Handling

Materials shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried and not dragged to the trench.

PART 2. PRODUCTS

2..1. *PIPE FOR SUBDRAINS*

Pipe for subdrains shall be of the types and sizes indicated.

2..1..1. Plastic Pipe

Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

2..1..1..1. Smooth-Wall Polyvinyl Chloride (PVC) Pipe and Couplings

Smooth-wall polyvinyl chloride (PVC) pipe and couplings shall conform to \-ASTM F 758-\, Type PS 46, produced from PVC certified by the compounder as meeting the requirements of \-ASTM D 1784-\, minimum cell class 12454B.

2..1..1..2. Pipe Perforations

Water inlet area shall be a minimum of 0.5 square inch per linear foot. Manufacturer's standard perforated pipe which essentially meets these requirements may be substituted with prior approval of the Contracting Officer.

a. Circular Perforations in Plastic Pipe: Circular holes shall be cleanly cut not more than 3/8 inch) or less than 3/16 inch in diameter and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 3 inches center-to-center along rows. The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.

b. Slotted Perforations in Plastic Pipe: Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots shall not exceed 1/8 inch nor be less than 1/32 inch. The length of individual slots shall not exceed 1-1/4 inches on 3 inch diameter tubing, 10 percent of the tubing inside nominal circumference on 4 to 8 inch diameter tubing, and 2-1/2 inches on 10 inch diameter tubing. Rows of slots shall be symmetrically spaced so that they are fully contained in 2 quadrants of the pipe. Slots shall be centered in the valleys of the corrugations of profile wall pipe.

2..2. NOT USED

2..3. NOT USED

2..4. NOT USED

2..5. NOT USED

2..6. DRAINAGE LAYER MATERIAL

Drainage layer material shall conform to Section \=02243=\ DRAINAGE LAYER. Bituminous or cement stabilization of open graded materials in subdrain trench shall not be required.

PART 3. EXECUTION

3..1. EXCAVATION AND BEDDING FOR SUBDRAIN SYSTEMS

3..1..1. Perforated Subdrain Pipe

Trenching and excavation, including the removal of rock and unstable material, shall be in accordance with Section \=02243=\. Bedding material shall be placed in the trench as indicated or as required as replacement materials used in those areas where unstable materials were removed. Compaction of the bedding material shall be as specified for cohesionless material in Section \=02243=\.

3..1..2. Non-Perforated Outfall Pipe

Excavation, trenching, and backfilling for non-perforated subdrain outfall pipe shall be in accordance with the applicable portions of Section \=02222=\ EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Bedding shall be Class B type as shown on the drawings.

3..2. NOT USED

3..3. NOT USED

3..4. NOT USED

3..5. INSTALLATION OF DRAINAGE LAYER MATERIAL AND BACKFILLING FOR SUBDRAINS

3..5..1. Test Section

A 50-foot long test section shall be constructed by the Contractor prior to final installation of drainage layer material in subdrain trenches. The test section data will be used by the Contracting Officer to determine the required procedures to be used to install drainage layer material in the subdrain trench.

3..5..2. Procedure

After the trench has been excavated, lined with geotextile, and approved by the Contracting Officers Representative, the drainage layer material bedding for the subdrain pipe shall be placed. Drainage layer material shall be compacted in a moist condition using a vibratory plate compactor. Each layer shall be compacted with a minimum of 3 passes of the vibratory plate compactor. Drainage layer material shall be placed in maximum 6-inch lifts to 12 inches above the top of the pipe. The pipe shall be inspected for damage and/or compression along the test section. Any damaged and/or compressed pipe shall be replaced as directed by the Contracting Officer's Representative at no additional cost to the Government.

3..5..3. Final Installation Procedures

The Contracting Officer's Representative shall evaluate the test section and determine the final installation procedures to be used to install drainage layer material along the remainder of subdrain trenches.

3..6. TESTS

3..6..1. \+Pipe Test+

Strength tests of pipe shall conform to field service test requirements of the Federal Specification, ASTM specification, or AASHTO specification covering the product (paragraph PIPE FOR SUBDRAINS).

SECTION 02720

STORM-DRAINAGE SYSTEM

SECTION 02720

STORM-DRAINAGE SYSTEM

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

\-AASHTO M 36-\	(1991) Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
\-AASHTO M 190-\	(1988) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
\-AASHTO M 198-\	(1994) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
\-AASHTO M 243-\	(1994) Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 36-\	(1994) Structural Steel
\-ASTM A 48-\	(1994a) Gray Iron Castings
\-ASTM A 307-\	(1994) Carbon Steel Bolts and Studs, 60000 psi Tensile
\-ASTM A 444-\	(1989) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process for Storm Sewer and Drainage Pipe
\-ASTM A 536-\	(1984; R 1993) Ductile Iron Castings
\-ASTM A 760-\	(1995a) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
\-ASTM A 798-\	(1994) Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
\-ASTM A 807-\	(1994) Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
\-ASTM C 231-\	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
\-ASTM C 270-\	(1995) Mortar for Unit Masonry

\-ASTM C 443-\	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
\-ASTM C 478-\	(1994) Precast Reinforced Concrete Manhole Sections
\-ASTM D 1056-\	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
\-ASTM D 1171-\	(1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
\-ASTM D 1751-\	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
\-ASTM D 1752-\	(1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

1..2. NOT USED

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-06 Instructions\

Placing Pipe\; *FIO*\.

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

SD-13 Certificates\

Pipe For Culverts and Storm Drains\; *FIO*\.

Certification demonstrating conformance to applicable pipe specifications, before pipe is installed.

Frame and Cover or Gratings\; *FIO*\.

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

1..4. DELIVERY, STORAGE, AND HANDLING

1..4..1. Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Gasket materials and plastic materials shall be protected from exposure to the direct sunlight over extended periods.

1..4..2. Handling

Materials shall be handled in such a manner as to ensure delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2. PRODUCTS

2..1. *PIPE FOR CULVERTS AND STORM DRAINS*

Pipe for culverts and storm drains shall be non-perforated and of the sizes indicated and shall conform to the requirements specified.

2..1..1. Corrugated Steel Pipe

\-ASTM A 760-\, zinc coated, 16 gage pipe:

Type I pipe with helical 2-2/3 x 1/2 inch corrugations.

2..2. JOINTS

Pipe joints shall be one of the following types

2..2..1. Corrugated Metal Pipe

Unless otherwise specified herein, bands shall meet the requirements specified in the applicable standards or specifications for the pipe and shall meet the general performance requirements described in \-ASTM A 798-\. Joints shall be made with outside bands, each band consisting of one or two pieces. The ends of the pipe sections shall be placed within approximately 1 inch to enable corrugations of the bands to mesh with the corrugations of the pipe. Space between pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber, or plastic to take up slack and insure a tight joint. The annular space between abutting sections of part-paved, and fully-paved pipe and pipe arch, in sizes 30 inches or larger, shall be filled with a bituminous material after jointing. Coupling bands may be the next thickness lighter than that used for the pipe but not more than 0.109 inch nor less than 0.052 inch thick and shall be the same material and have the same coating as specified for the pipe being used. Exterior rivet heads in the longitudinal seam of riveted pipe under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Pipe with helical corrugations shall have each end factory reformed to annular corrugations of the same dimensions as those in the pipe. Width of reformed end shall be equal to at least half the width of the band being used.

2..2..1..1. Coupling Bands.

Coupling bands shall be one of the following types:

a. Bands with Annular Corrugations and Rod and Lug Type Connector: Bands shall have a sleeve type gasket and shall be not less than four corrugations wide for pipe 12 inch to 24 inch in diameter and not less than eight corrugations wide for pipe 30 inch and greater in diameter. Four-corrugation wide bands shall have two rods and lugs and eight-corrugation wide bands shall have four rods and lugs. The corrugations in the band shall have the same dimensions as the corrugations in the pipe end.

b. Semi-Corrugated (Hugger) Bands with Rod and Lug Type Connector: Bands shall have two O-ring gaskets, a sealant strip where the band ends overlap, and shall be not less than 10-1/2 inches wide. Bands shall have two rods and lugs with a single harness, bolt, bar, and strap connector.

c. Bands with Annular Corrugations and Angle-Bolt Type Connector: Bands shall have a sleeve-type gasket and shall be not less than 7 inches wide for pipe 12 inch to 24 inch in diameter, 12 inches wide for pipe 30 inch to 60 inches in diameter, and 24 inches wide for pipe 66 inch to 120 inches in diameter. The 7 inch wide bands shall have not less than two bolts per connection, the 12 inch wide bands not less than three, and the 24 inch wide bands not less than five bolts per connection. The corrugations in the band shall have the same dimensions as the corrugations in the pipe end.

2..2..1..2. Gaskets.

a. Sleeve Gaskets: Sleeve gaskets used with circular pipe having not more than 5 percent ellipse shall be made of approximately 3/8 inch thick by 7 inch minimum width closed cell, expanded synthetic rubber, fabricated in the form of a cylinder with a diameter approximately 10 percent less than the nominal pipe size. The gasket material shall conform to the requirements of \-ASTM D 1056-\, Type 2 A1, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of \-ASTM D 1171-\. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall then be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened.

b. O-Ring Gaskets: Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugations. O-ring gaskets shall be 1-3/8 inch diameter for pipe having 1 inch deep end corrugations. Rubber O-ring gaskets shall conform to the requirements of \-AASHTO M 198-\ or \-ASTM C 443-\.

2..2..1..3. Connectors.

a. Rod and Lug: Rods shall be not less than 1/2 inch in diameter and shall conform to \-ASTM A 307-\. Lugs shall be manufactured with material conforming to \-ASTM A 48-\, class 35B. Nuts shall conform to the requirements of \-AASHTO M 36-\. Rods, lugs, and nuts shall be zinc or cadmium coated in accordance with \-AASHTO M 36-\.

b. Bolt, Bar, and Strap: The connection bolts shall be zinc or cadmium coated, not less than 1/2 inch in diameter per connection, and shall

conform to the requirements of \-AASHTO M 36-\. Bars shall be not less than 7/8 inch in diameter and straps shall be not less than 0.109 inches in thickness. Bars and straps shall be zinc-coated in accordance with \-AASHTO M 36-\.

c. Angle-Bolt: Angles shall be not less than 2 inches by 2 inches by 3/16 inch by the width of the band minus 1 inch, adequately fastened to each end of band and half bands. The angles shall conform to \-ASTM A 36-\ and shall be zinc-coated in accordance with \-AASHTO M 36-\. The connection bolts shall be zinc or cadmium coated, not less than 12.7 mm (1/2 inch) in diameter per connection. Bolts and nuts shall conform to the requirements of \-AASHTO M 36-\.

2..2..1..4. Installation.

Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket shall be closely observed to see that it is seating properly in the corrugations. Joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the rods or bolts, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

2..3. DRAINAGE STRUCTURES

2..3..1. Manholes

Construction shall be of precast reinforced concrete manhole sections, complete with frames and covers where indicated. Manhole bases shall be cast-in-place or precast reinforced concrete. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure.

2..3..2. Curb and Area Inlets

Construction shall be of cast-in-place as indicated.

2..3..3. Flared End Sections

Sections shall be of the standard design of the pipe manufacturer. Sections for corrugated steel pipe shall be fabricated from steel sheets meeting requirements of \-ASTM A 444-\ and shall have the same sheet thickness and metallic coating as specified for the pipe. Concrete pipe and pipe arch flared end sections shall be of the standard design of the pipe manufacturer.

2..4. MISCELLANEOUS MATERIALS

2..4..1. Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 20 MPa concrete under Section \=03300A=\ CAST-IN-PLACE STRUCTURAL CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches Air content shall be determined in accordance with \-ASTM C 231-\. The concrete covering over steel reinforcing shall not be less than 1-1/2

inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to \-ASTM D 1751-\, or \-ASTM D 1752-\, or shall be resin-impregnated fiberboard conforming to the physical requirements of \-ASTM D 1752-\.

2..4..2. Mortar

Mortar for pipe joints and connections to other drainage structures shall conform to \-ASTM C 270-\, Type M, except the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed 5 gallons of water per sack of cement. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2..4..3. *Frame and Cover or Gratings*

Frame and cover or gratings shall be cast gray iron, \-ASTM A 48-\, Class 35B or cast ductile iron, \-ASTM A 536-\, Grade 65-45-12. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans. Covers and gratings shall have a minimum transverse proof-load strength of 25,000 pounds.

PART 3. EXECUTION

3..1. EXCAVATION, TRENCHING, AND BACKFILLING FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches and for appurtenances and backfilling for culverts and storm drains shall be in accordance with the applicable portions of Section \=02222=\ EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3..2. BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. Bedding shall conform to the details on the drawings and shall be in accordance with the applicable portions of Section \=02222=\ EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. The following types of bedding shall be used:

3..2..1. Corrugated Metal Pipe

Bedding for corrugated metal pipe and pipe arch shall be Class C type bedding as shown on the drawings or shall be in accordance with \-ASTM A 798-\. If Class C bedding is used, select material shall be used for initial backfill. If bedding is in accordance with \-ASTM A 798-\, it is not required to shape the bedding to the pipe geometry. However, for pipe arches, it is recommended to either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow V-shape. Bedding for corrugated structural plate pipe shall meet requirements of \-ASTM A 807-\.

3..3. *PLACING PIPE*

Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to the direct sunlight prior to laying as needed to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed plastic pipe shall not exceed 4.5 percent of the nominal inside diameter. After backfilling has been completed, the Government may perform a deflection test on the entire length of installed plastic pipeline using a mandrel or other suitable device. Any plastic pipe showing deflections in excess of 4.5 percent shall be removed and replaced at the Contractor's expense. All pipe in place shall be inspected before backfilling, and those pipes damaged during placement shall be removed and replaced.

3..3..1. Corrugated Metal Pipe

Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material specified in \-AASHTO M 190-\ or \-AASHTO M 243-\. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During installation, pipe or pipe arch shall be handled with care to preclude damage to the bituminous coating or paving. Prior to placing backfill, damaged areas of coupling bands and pipe shall be given a coating of bituminous material, specified in \-AASHTO M 190-\ or \-AASHTO M 243-\. Pipe on which bituminous coating has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

SECTION 02935
TURF

SECTION 02935
TURF

PART 1 GENERAL

1.1 SUMMARY

Seed varieties and quantities specified shall be uniformly distributed over all ground areas disturbed by grading and/or trenching and not otherwise surfaced and in such manner that will produce an even stand of grass over the entire area seeded and as specified.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AGRICULTURAL MARKETING SERVICE (AMS)

AMS-01(Amended Thru: Aug 1988) Federal Seed Act Regulations (Part 201-202)

COMMERCIAL ITEM DESCRIPTION (CID)

CID A-A-1909 (Basic) Fertilizer

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS DESCRIPTIONS

SD-08 Statements\

Maintenance Report\; *FIO*\.

Written record of all maintenance work performed during the turf establishment period shall be submitted to the Contracting Officer.

SD-13 Certificates\

Certificates of compliance certifying that materials meet the requirements specified, in accordance with paragraph MATERIALS, prior to the delivery of materials. Certified copies of the reports for the following materials shall be included:

Seed\; *GA2*\.

For mixture, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, date tested, and state certification.

1.4 INSPECTION, STORAGE, AND HANDLING

1.4.1 Inspection

Seed, shall be inspected upon arrival at the job site by the Contracting Officer for conformity to type and quality in accordance with paragraph MATERIALS.

1.4.2 Storage

Materials shall be stored in areas designated by the Contracting Officer. Seed, Fertilizer, Lime shall be stored in cool, dry locations away from contaminants.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 *Seed*

2.1.1.1 Seed Classification

State Certified seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS-01 and applicable state seed laws.

2.1.1.2 Seed Mixtures

Seed mixtures shall be proportioned by weight as follows:

Name	Mixture Percent by Weight	Pounds of Seed Per 1,000 S.F.
Common Bermudagrass	10	0.8
Turf Type Tall Fescue Rebel II or Rebel III	90	7.2
	Total	8.0

2.1.1.3 Quality

Weed seed shall not exceed 1 percent by weight of the total mixture. Wet, moldy, or otherwise damaged seed shall be rejected.

2.1.1.4 Seed Mixing

The mixing of the seed shall be done by the Seed Supplier prior to delivery to the site. Bulk quantities of seed shall be labeled as required in the paragraph Seed Classification.

2.1.2 Soil Amendments

Soil amendments shall consist of fertilizer and lime meeting the following requirements.

2.1.2.1 Fertilizer

Fertilizer shall be commercial grade, free flowing, low in salts, uniform in composition and conforming to CID A-AA-1909. Granular fertilizer shall

consist of nitrogen-phosphorus-potassium, ratio: 10 parts nitrogen, 20 parts phosphorus, and 10 parts potassium.

2.1.2.2 Lime

Lime shall be agricultural limestone and shall have a minimum calcium magnesium oxides equivalent of 50 percent and shall be ground to such a fineness that at least 90 percent will pass a 10-mesh sieve and at least 50 percent will pass a 60-mesh sieve.

2.1.3 Topsoil

If additional topsoil is required beyond that available from grading operations, it shall be furnished by the Contractor and shall be a natural, friable soil representative of productive soils in the vicinity, and approved by the Contracting Officer. It shall be obtained from well-drained areas and shall be free of any admixture of subsoil, foreign matter, objects larger than 1 inch in any dimension, toxic substances, and any material or substance that may be harmful to plant growth. Topsoil shall be in accordance with Section 02210 GRADING.

2.1.4 Mulch

The Contractor shall use hay or straw fixed in place on all surfaces. All other mulch materials and/or methods of application shall be approved by the Contracting Officer. Mulch shall be free from weeds, mold, and other objectionable materials. Contractor shall also have the option of using Hydromulch with tackifier applied simultaneously with grass, seed, and fertilizer by the use of hydroseeding machinery on slopes less than 3 horizontal to 1 vertical.

2.1.4.1 Straw

Straw Mulch shall be long stem threshed straw of oats, wheat or rye that is free from noxious weeds, mold or other objectionable material. The straw mulch shall contain at least 50 percent by weight of the material to be 10 inches or longer. Straw shall be in an air-dry condition and suitable for placing with blower equipment.

2.1.4.2 Hay

Hay shall be native prairie hay furnished in an air-dry condition suitable for placing with commercial mulch-blowing equipment. Hay shall be free of noxious weeds, mold or other objectionable material.

2.1.4.3 Hydromulch for Hydroseeding

Hydromulch shall be made of virgin, long fiber wood cellulose made from whole wood chips or lumber remnants and not contain any growth or germination inhibiting factors and shall be dyed an appropriate color to facilitate visual metering during application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 4.5 to 6.0. Hydromulch shall include a tackifier to provide added bonding between cellulose fibers and to help hold seed, fertilizer and soil in place and to promote seed germination. Tackifier shall weigh a minimum 3%, on an air dry weight basis, of the mulch mix.

2.1.4.4 Hydromulch Tackifier

Hydromulch tackifier shall be a natural vegetable gum, blended with gelling and hardening agents. When mixed with water this material becomes a tackifier/binder to act as an agent for erosion control and provides a stable bed for seed germination.

2.1.4.5 Paperfiber Mulch Overspray

Paperfiber mulch overspray shall be produced from slick paper containing wood cellulose and kaolin clay, recycled newsprint or cardboard will not be allowed. The material is shredded for the purpose of mulching as an overspray binder on straw mulched areas. It shall not contain any growth or germination-inhibiting substances. The mulch shall be green in color for visual metering of the material application. Composition on an air dry weight basis shall be: 8 percent moisture content, pH range 4.5 to 6.5.

2.1.5 Water

Water shall not contain elements toxic to plant life and shall be obtained from an approved source prior to use.

PART 3 EXECUTION

3.1 SEEDING TIMES AND CONDITIONS

3.1.1 Seeding Time

Seed shall be sown for spring planting from March 15 to June 1, for fall planting from August 1 to Oct 15.

3.1.2 Environmental Conditions

Seeding, operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the operations, proposed times shall be submitted to and approved by the Contracting Officer.

3.2 SITE PREPARATION

3.2.1 Grading

The Contracting Officer shall verify that finished grades are as indicated on the drawings, and the placing of topsoil and smooth grading have been completed in accordance with Section 02210 GRADING. Any deviations therefrom shall be corrected prior to seeding. Soil used for repair of erosion and correction of grade deficiencies shall conform to that specified in the paragraph Topsoil.

3.2.2 Tillage

3.2.2.1 Minimum Depth

Soil on slopes gentler than 3-horizontal-to-1-vertical shall be tilled to a minimum depth of 6 inches. Slopes between 3-horizontal-to-1-vertical and

1-horizontal-to-1 vertical, the soil shall be tilled to a minimum depth of 2 inches by scarifying with heavy rakes, rotating chains drawn by tractor from the top of the slope, or rototillers when soil conditions and length of slope permit. On slopes 1-horizontal-to-1 vertical and steeper, no tillage is required.

3.2.3 Finished Grading

3.2.3.1 Preparation

Turf areas shall be filled as needed or have surplus soil removed to attain the finished grade. Drainage patterns shall be maintained as indicated on drawings. Turf areas compacted by construction operations shall be completely pulverized by tillage. Finished grades adjacent to walks, curbs, pavements, shall be 1 inch below the adjoining surfaced area. New soil surfaces shall be blended to meet existing soil surfaces.

3.2.3.2 Grass Area Debris

Grass areas shall have debris and stones larger than 1 inch in any dimension removed from the surface.

3.2.3.3 Protection

Finished graded areas shall be protected from damage by vehicular or pedestrian traffic and erosion.

3.2.4 Application of Soil Amendments

3.2.4.1 Lime

Lime shall be applied at the rate of 2 tons per acre. Lime shall be incorporated into the soil to a minimum depth of 6 inches or may be incorporated as part of the tillage operation.

3.2.4.2 Fertilizer

Fertilizer shall be applied at a rate of 1 pound of actual nitrogen per 1,000 square feet for seeding. Fertilizer shall be incorporated into the soil to a minimum depth of 6 inches or may be incorporated as part of the tillage or hydroseeding operation. Fertilizer may be applied simultaneously with seed and hydromulch when hydroseeding.

3.3 SEEDING

3.3.1 General

Prior to seeding, any previously prepared seedbed areas compacted or damaged by interim rain, traffic or other cause, shall be reworked to restore the ground condition previously specified. Seeding operations shall not take place when the wind velocity will prevent uniform seed distribution.

3.3.2 Applying Seed

3.3.2.1 Broadcast Seeding

Seed shall be uniformly broadcast at the rates specified using broadcast seeders. Half of seed shall be broadcast in one direction, and the remainder at right angles to the first direction. Seed shall be covered to an average depth of 1/4 inch but no more than 3/4 inch by steel mat drag, cultipacker, or other approved device.

3.3.2.2 Drill Seeding

Seed shall be uniformly drilled to an average depth of 1/2 inch at the rate specified using a Brillon type seeder. Row markers shall be used with the drill seeder. Drill seeding shall be done in two directions, 90 degrees in direction from the other, each direction at half the rate specified.

3.3.2.3 Rolling

Immediately after seeding, except for slopes 3-horizontal-to-1 vertical and greater, the entire area shall be firmed with a roller not exceeding 90 pounds for each foot of roller width. Areas seeded with seed drills equipped with rollers shall not be rolled.

3.3.3 Hydroseeding

Seed and fertilizer shall be added to water and thoroughly mixed at the rates specified. Hydromulch and Tackifier shall be added after the seed, fertilizer and water have been thoroughly mixed. Mix shall include a minimum of 1,500 pounds of mulch and tackifier, per acre, on slopes 2.5H : 1V or flatter and 2,000 pounds of mulch and tackifier, per acre, on slopes steeper than 2.5H : 1V. Slurry shall be uniformly applied to all seeded surfaces. Adequate soil moisture shall be ensured by spraying water on the entire hydroseeded area and moisten the soil to a minimum depth of 2 inches prior to hydroseeding. The hydroseeded area shall not be rolled.

3.3.4 Mulching

Mulching shall be performed the same day as seeding. Unless specified otherwise mechanical anchoring of mulch shall be performed.

3.3.4.1 Straw or Hay Mulch

Straw or hay mulch shall be spread uniformly, in a continuous blanket, at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of a steep slope and continued uniformly until the area is covered. The mulch shall not be bunched. All seeded areas shall be mulched on the same day as the seeding.

3.3.4.2 Mechanical Anchoring

Immediately following spreading, the mulch shall be anchored to the soil by a V-type-wheel land packer, a scalloped-disk land packer designed to force mulch into the soil surface a minimum of 2 inches, or other suitable equipment.

3.3.4.3 Hydromulch

Hydromulch for use with the hydraulic application of seed, fertilizer and tackifier shall be applied as part of the hydroseeding operation.

3.3.5 Watering Seeded Areas

Watering of seeded areas is not required.

3.4 RESTORATION AND CLEAN UP

3.4.1 Restoration

Existing turf areas, pavements and facilities that have been damaged from the turfing operation shall be restored to original condition at Contractor's expense.

3.4.2 Clean Up

Excess and waste material shall be removed from the planting operation and shall be disposed of off the site. Adjacent paved areas shall be cleaned.

3.5 PROTECTION OF TURFED AREAS

Immediately after mulching operations have been completed, the area shall be protected against traffic or other use by erecting barricades and providing signage as required or as directed by the Contracting Officer to provide protection against traffic and trespass.

3.6 TURF ESTABLISHMENT PERIOD

3.6.1 Commencement

The Turf Establishment Period for establishing a healthy stand of turf shall begin on the first day of work under this contract and shall end 60 days after the last day of mulching operations required by this contract or until all work on this entire Contract has been completed and accepted, whichever period is longer.

3.6.1.1 Satisfactory Stand of Turf

A satisfactory stand of turf for a seeded area is defined as having a minimum of 200 grass plants per square foot and having a mat like appearance. Bare spots shall be no larger than 6 square inches per foot. The total bare spots shall not exceed 2 percent of the total seeded area.

3.6.2 Maintenance During Turf Establishment Period

3.6.2.1 General

Maintenance of the turfed areas shall include eradicating weeds when evident, eradicating insects and diseases, protecting embankments and ditches from erosion, maintaining mulch, protecting turfed areas from traffic and mowing.

3.6.2.2 Mowing

Grass areas shall be mowed to a minimum height of 2-1/2 inches when the average height of the turf becomes 4 inches. Clippings shall be removed when the amount of cut turf is heavy enough to damage the turfed areas.

3.6.2.3 Repair

The Contractor shall re-establish as specified herein, eroded, damaged or barren areas. Mulch shall also be repaired or replaced as required.

3.6.2.4 *Maintenance Report*

A written record shall be furnished to the Contracting Officer of the maintenance work performed.

3.7 FINAL ACCEPTANCE

See specification SECTION, 01440, CONTRACTOR QUALITY CONTROL, for final inspection and acceptance.

SECTION 03300A

CONCRETE FOR BUILDING CONSTRUCTION

SECTION 03300A

CONCRETE FOR BUILDING CONSTRUCTION

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

\-ACI 318/318R-\	(1989; Rev 1992; Errata) Building Code Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 615-\	(1994) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
\-ASTM C 94-\	(1994) Ready-Mixed Concrete
\-ASTM C 309-\	(1993) Liquid Membrane-Forming Compounds for Curing Concrete

1..2. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-13 Certificates\

Cementitious Materials\; *GA*\.

Cement, pozzolan, and ground iron blast-furnace slag will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished. No cement, pozzolan, or slag shall be used until notice of acceptance has been given by the Contracting Officer. Cement, pozzolan, and slag may be subjected to check testing by the Government from samples obtained at the mill, at transfer points, or at the project site.

1..3. GENERAL REQUIREMENTS

1..3..1. Strength Requirements

Structural concrete for all work shall have a 28-day compressive strength of 3000 pounds per square inch. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II portland cement.

1..3..2. Air Entrainment

All concrete shall contain from 4 to 7 percent total air.

1..3..3. Special Properties

Concrete may contain other admixtures, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if approved.

1..3..4. Slump

Slump shall be within the following limits:

Structural Element	Slump in inches Minimum	Maximum
Foundation walls, substructure walls, footings, pavement, and slabs	1	3
Any structural concrete approved for placement by pumping	None	6

Where use of superplasticizers are approved to produce flowing concrete these slump requirements do not apply.

PART 2. PRODUCTS

2..1. CONCRETE INGREDIENTS

Concrete shall conform to \-ASTM C 94-\; type V.

2..2. CURING MATERIALS

Curing materials shall be burlap, impervious sheets, or membrane-forming compounds.

2..3. EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel.

2..4. FORM MATERIALS

Forms for concrete surfaces shall be metal, plywood, or hardboard capable of producing the required surface without adverse effect on the concrete. Form coating shall be nonstaining form oil or form release agent that will not adversely affect the concrete surfaces or impair subsequent applications to the concrete. Form ties shall be metal, factory-fabricated, removable or snap-off type that will not leave holes less than 1/4 inch nor more than 1 inch deep and not more than 1 inch in diameter.

2..5. NOT USED

2..6. NOT USED

2..7. REINFORCEMENT

Bar reinforcement shall be deformed, Grade 40 or Grade 60 billet steel conforming to \-ASTM A 615-\. Mesh reinforcement shall be welded steel wire fabric with wires at right angles to each other.

2..8. NOT USED

2..9. WATER

Water shall be potable.

PART 3. EXECUTION

3..1. PREPARATION OF SURFACES

Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Conduit and other similar items shall be in place and clean of any deleterious substance. Surfaces shall be moist but without free water when the concrete is placed.

3..2. FORMWORK

Formwork shall be mortar-tight, properly aligned, and adequately supported to produce concrete conforming accurately to the indicated shapes, lines, dimensions, and with surfaces free of offsets, waviness, or bulges. Where surfaces are to be exposed or painted, panels shall be of uniform sizes, using smaller panels only where required by openings, joints or for closure. Unless otherwise shown, exposed external corners shall be chamfered, beveled or rounded by moldings placed in the forms. Form surfaces shall be thoroughly cleaned and coated before each use. Forms shall be removed at a time and in a manner that will not injure the concrete.

3..3. INSTALLATION OF REINFORCEMENT

Reinforcement shall be fabricated to the required shapes. Reinforcement shall be interrupted 2 inches on each side of expansion joints. Reinforcement shall be accurately positioned and secured in place.

3..4. NOT USED

3..5. NOT USED

3..6. INSTALLATION OF EMBEDDED ITEMS

Embedded items shall be free from oil, loose scale or rust, and paint. Embedded items shall be installed at the locations indicated and required to serve the intended purpose. Voids in sleeves, slots and inserts shall be filled with readily removable material to prevent the entry of concrete.

3..7. BATCHING, MIXING AND TRANSPORTING CONCRETE

The work shall conform to \-ACI 318/318R-\ part Construction Requirements, except as otherwise specified.

3..8. CONCRETE PLACEMENT

Concrete shall be handled from mixer to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 8 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level to avoid excessive shimming or grouting.

3..9. CONSOLIDATION

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 8000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then withdrawn slowly. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique.

3..10. WEATHER LIMITATIONS

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The temperature of the concrete placed during warm weather shall not exceed85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 95degrees F.~\

3..11. CONSTRUCTION JOINTS

Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer.

3..12. FINISHING CONCRETE

3..12..1. Formed Surfaces

Fins and loose material shall be removed. Unsound concrete, voids over 1/2 inch in diameter, and tie-rod bolt holes shall be cut back to solid concrete, reamed, brush-coated with cement grout, and filled solid with a stiff portland cement and sand mortar mix. Patchwork shall finish flush with adjoining concrete surfaces in texture and color. Patchwork shall be cured for 72 hours.

3..12..2. Unformed Surfaces

3..12..2..1. Rough-Slab Finish

Slabs to receive fill or mortar setting beds shall be screeded with straightedges immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible.

3..12..2..2. Float Finish

Slabs to receive a steel trowel finish float finish. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated. Lightweight concrete or concrete that portrays stickiness shall be finished with a magnesium float in lieu of a wood float, and left free of ridges and other projections.

3..12..2..3. Trowel Finish

All slabs shall be given a trowel finish immediately following floating. Surfaces shall be trowelled to produce smooth, dense slabs free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling shall be done by hand.

3..13. CURING AND PROTECTION

3..13..1. General

Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period.

3..13..2. Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials used stains or discolors concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 2 inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap.

3..13..3. Membrane Curing

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete; except a styrene acrylate or chlorinated rubber compound meeting \-ASTM C 309-\, Class B requirements may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. On surfaces permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3..14. SETTING BASE PLATES AND BEARING PLATES

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 1 inch. Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed.

SECTION 05120

STRUCTURAL STEEL

SECTION 05120

STRUCTURAL STEEL

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

\-AISC S303-\	(1992) Code of Standard Practice for Steel Buildings and Bridges
\-AISC S335-\	(1989) Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 36-\	(1994) Carbon Structural Steel
\-ASTM A 307-\	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
\-ASTM A 500-\	(1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
\-ASTM F 844-\	(1990) Washers, Steel, Plain (Flat), Unhardened for General Use

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME B18.21.1-\	(1994) Lock Washers (Inch Series)

AMERICAN WELDING SOCIETY (AWS)

\-AWS A2.4-\	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination
\-AWS D1.1-\	(1994) Structural Welding Code - Steel

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

\-SSPC Paint 25-\	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)

1..2. GENERAL REQUIREMENTS

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude. The Contractor shall be responsible for correctness of detailing, fabrication,

and for the correct fitting of structural members. Connections, for any part of the structure not shown on the contract drawings, shall be considered simple shear connections and shall be designed and detailed in accordance with pertinent provisions of \-AISC S329-\. Substitution of sections or modification of connection details will not be accepted unless approved by the Contracting Officer. \-AISC-S335-\ shall govern the work. Welding shall be in accordance with \-AWS D1.1-\. .

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Structural Steel System\; *GA1*\.

Structural Connections\; *GA1*\.

Shop and erection details including members (with their connections) not shown on the contract drawings. Welds shall be indicated by standard welding symbols in accordance with \-AWS A2.4-\.

SD-13 Certificates\

Mill Test Reports\; *FIO*\.

Certified copies of mill test reports for structural steel, structural bolts, nuts, washers and other related structural steel items.

Welder Qualifications\; *FIO*\.

Certified copies of welder qualifications test records showing qualification in accordance with \-AWS D1.1-\.

SD-14 Samples\

Carbon Steel Bolts and Nuts\; *FIO*\.

Washers\; *FIO*\.

Random samples of bolts, nuts, and washers as delivered to the job site if requested, taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

1..4. STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

PART 2. PRODUCTS

2..1. STRUCTURAL STEEL

2..1..1. Carbon Grade Steel

Carbon grade steel shall conform to \-ASTM A 36-\ .

2..2. STRUCTURAL TUBING

Structural tubing shall conform to \-ASTM A 500-\, Grade B .

2..3. NOT USED

2..4. NOT USED

2..5. NOT USED

2..6. CARBON STEEL BOLTS

Carbon steel bolts shall conform to \-ASTM A 307-\, Grade A with carbon steel nuts conforming to \-ASTM A 563-\, Grade A.

2..7. NUTS DIMENSIONAL STYLE

Carbon steel nuts shall be Hex Style .

2..8. *WASHERS*

Plain washers shall conform to \-ASTM F 844-\. Other types, when required, shall conform to \-ASME B18.21.1-\ .

2..9. PAINT

Paint shall conform to \-SSPC Paint 25-\.

PART 3. EXECUTION

3..1. FABRICATION

Fabrication shall be in accordance with the applicable provisions of \-AISC-04-\. Fabrication and assembly shall be done in the shop to the greatest extent possible. Structural steelwork, except surfaces of steel to be encased in concrete and surfaces to be field welded shall be prepared for painting in accordance with the \-AISC-04-\ and primed with the specified paint.

3..2. ERECTION

Erection of structural steel shall be in accordance with the applicable provisions of \-AISC-S335-\.

3..2..1. Connections

Anchor bolts and other connections between the structural steel and foundations shall be provided and shall be properly located and built into connecting work.

3..2..2. Base Plates and Bearing Plates

Column base plates for columns and bearing plates for similar members shall be provided. Base plates and bearing plates shall be provided with full bearing after the supported members have been plumbed and properly positioned, but prior to placing superimposed loads. Separate setting plates under column base plates will not be permitted. The area under the plate shall be damp-packed solidly with bedding mortar. Bedding mortar be as specified in Section \=03300=\ CONCRETE FOR BUIDLING CONSTRUCTION.

3..2..3. Field Welded Connections

Field welded structural connections shall be completed before load is applied.

3..2..4. Field Priming

After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

SECTION 15050

MECHANICAL EQUIPMENT, FUELING

SECTION 15050

MECHANICAL EQUIPMENT, FUELING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME B16.5-\	(1988; Errata) Pipe Flanges and Flanged Fittings
\-ASME B40.1-\	(1991) Gauges--Pressure Indicating Dial Type--Elastic Element
\-ASME-16-\	(1992; Addenda Dec 1992, Dec 1992, Dec 1994) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1

AMERICAN PETROLEUM INSTITURE (API)

\-API BULL 1529-\	(1989) Aviation Fueling Hose

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

\-ASTM C 827-\	(1987) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
\-ASTM A 48-\	(1983; R 1990) Gray Iron Castings
\-ASTM A 536-\	(1984) Ductile Iron Castings

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 30-\	(1990) Flammable and Combustible Liquids Code
\-NFPA 70-\	(1996) National Electric Code

MILITARY SPECIFICATIONS (MS)

\-MS MIL-C-4556-\	(Rev. E, 1990) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
\-MS MIL-P-24441-\	(Rev. B, 1991; Supp. 1) General Specification for Paint, Epoxy - Polyamide

\-MS MIL-T-83133-\	(Rev. C, 1990; Amend. 1) Turbine Fuels, Aviation, Kerosene Types, NATO F-34(JP-8) and NATO F-35

MILITARY STANDARDS (MIL-STD)

\-MIL-STD-130-\	(Rev. G, 1988) Identification Marking of U.S. Military Property
\-MIL-STD-161-\	(Rev. F, 1985; Notice 2) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

\-SAE AMS 3275A-\	(1994) Acrylonitrile Butadiene (NRB) Rubber Sheet, Non-Asbestos Fiber Fuel and Oil Resistant

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having and "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Pressure Gages\; *GA*\ (Para. 2.5).

Flow Switch\; *GA*\ (Para. 2.8).

Air Eliminator Tank and Equipment\; *GA*\

Manufacturer's Catalog Data

Air Eliminator Tank and Equipment\; *GA*\.

Provide the design analysis as one package with detail drawings. The design analysis shall be signed by a Registered Professional Engineer shall include a list of the design loads, and complete calculations for the vault.

SD-04 Drawings\

Air Eliminator Tank and Equipment\; *GA*\.

Provide the drawings as one package with the design analysis. Shop fabrication drawings shall include type of material, configuration, thickness, and necessary details of construction of the steel tank and vault. Shop drawings shall also show the steel grating and supports.

SD-09 Reports\

Test Reports

SD-13 Certificates\.

Coating Products\; *GA*\.

U.L. Labeled products\; *GA*\.

Certificates of Compliance

SD-19 Operating and Maintenance Manuals\.

Pressure Gauges\; *GA*\.

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Components shall be suitable for use with JP-8 turbine fuel; specific gravity 0.81 at 60 degrees F., viscosity 1.62 CS at 60 degrees F., Reid vapor pressure less than 0.05 psi, \-MS MIL-T-83133-\. Components to be ANSI Class 150 (275 PSIG at 100 degrees F.) unless noted otherwise. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between 10 degrees F. and 100 degrees F.

2.2 COMPOSITION OF MATERIALS

Materials in contact with the fuel shall be noncorrosive. No zinc-coated metals, brass, bronze, or other bearing alloys shall be used in contact with the fuel.

2.3 ELECTRICAL WORK

Motors, manual or automatic motor control equipment except where installed in motor control centers, and protective or signal devices required for the operation specified herein shall be provided under this section in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR.

2.4 MATERIALS AND EQUIPMENT

All items of material and equipment shall be new and of the best quality used for the purpose in commercial practice and shall be products of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, address and catalog number on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable. The gears, couplings, projecting set screws, keys and other rotating parts located so that any person may come in close proximity thereto shall be fully enclosed or properly guarded. Equipment, assemblies and parts shall be marked for identification in accordance with \-MIL-STD-130-\ and \-MIL-STD-161-\. Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating valve number shall be installed on valves. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

2.4.1 Supplier

The Contractor's attention is directed to the fact that the pump control system, including but not limited to control panel, air eliminator tank and level sensors, and control valves with all hardware and software is an integrated system, shall be furnished by a single systems supplier regularly engaged in the supplying of this equipment. Supplier shall provide all equipment and appurtenances regardless of manufacture, and be responsible to the Contractor for satisfactory operation of the entire system. Substitutions of functions specified will not be acceptable. The Contractor shall coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system.

2.5 *PRESSURE GAGES*

Pressure gages shall conform to \-ASME B40.1-\ with metal cases and 4-inch diameter white dials. Gages shall be bottom connected, without back flanges. A pulsation dampener, adjustable to the degree of dampening required, shall be provided for each gage. Range of gages shall be as indicated. A ball valve shall be provided for each pressure gage. Gages shall have all parts immersed in silicone oil.

2.6 GASKETS

Gaskets shall be in accordance with Section \=15060=\ PIPE, MANUAL VALVES, AND FITTINGS, FUELING SYSTEM.

2.7 BOLTS AND NUTS

Bolts and nuts shall be in accordance with Section \=15060=\ PIPE, MANUAL VALVES, AND FITTINGS, FUELING SYSTEM.

2.8 Flow Switches

Switches shall be actuating vane type flow switch with single adjustable set-point. Switches shall mount on \-ASME B16.5-\ Class 150 raised face flange. Provide snap action switch mechanism U.L. listed for Class I, Division 1, Group D hazardous locations. Switches to be double pole double throw (DPDT). Switch power shall be 120 volts, single phase, 60 hertz, 10 amps minimum.

2.9 AIR ELIMINATOR TANK

2.9.1 Tank Housing

Each Tank housing shall be fabricated from carbon steel and shall be internally coated with an epoxy coating in accordance with \-MS MIL-C-4556. Coat the exterior with alkalyal resin primer (universal metal primer). Each unit shall be constructed and labeled in accordance with \-ASME 16-\. The housing shall be designed for a working pressure of 90 psig. The inlet and outlet connections shall be provided with raised face flanges faced and drilled in compliance with \-ASME B16.5-\, Class 150. The configuration of the air eliminator tanks shall be as shown on the drawings.

2.9.2 Sight Gauge

A ½-inch armored, clear pyrex liquid level gauge shall be provided for observing fuel level in the tank. The gauge shall be equipped with stainless steel ball checks in both the upper and lower fittings, an upper and lower shutoff valve, and a bottom blowoff cock. The gauge will contain a colored density sensitive ball. Glass shall be protected by a minimum of four guard rods.

2.9.3 High Level Shutoff

The vent connection shall have a stainless steel high level shutoff mechanism to act as an overfill prevention device to keep fuel from going out the vent.

2.9.4 Level Sensors

The level sensors shall be ultrasonic tip sensitive level control switches, \-NEMA 7/9-\, weatherproof, explosion proof for Class I, Div I, Group D, temperature T2D (419E F.), 120-volt input power, DPDT relay output, 1-inch flanged mounting.

2.9.5 Vent

Tank vent outlet shall be equipped with pressure-vacuum breather vent, aluminim construction with weather hood and with viton pallet seat inserts, high density screens, stainless steel internals, with pressure relief setting at ½ oz per square inch, and vacuum relief set at 32 oz per square inch. Pressure venting capacity shall be 5400 cubit feet per hour, vacuum capacity shall be 5000 cubic feet per hour.

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Installation

Install equipment and components in position, true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearances between equipment components. Equipment, apparatus, and accessories requiring normal servicing or maintenance to be accessible.

3.1.2 Anchoring

Anchor equipment in place. Check alignment of anchor bolts before installing equipment and clean-out associated sleeves. Do not cut bolts because of misalignment. Notify Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate self-drilling type anchors for construction condition.

3.1.3 Grouting

Equipment which is anchored to a pad shall be grouted in place. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water,

debris, oil, rust, and coatings which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide necessary formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting shall be in accordance with \-ASTM C 827-\. Perform all grouting in accordance with equipment manufacturer's and grout manufacturer's published specifications and recommendations.

3.1.4 Leveling and Aligning

Level and align equipment in accordance with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.1.5 Direct Drives

Alignment procedure follows:

3.1.5.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.1.5.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.1.5.3 Shaft Leveling and Radial Alignment

Check shaft leveling by placing a spirit level across the half faces. Radially align shafts by placing a straightedge across the two coupling half faces in both horizontal and vertical planes.

3.1.5.4 Angular Alignment and End Clearance

Check angular alignment and end clearance by inserting a feeler gage at 4 points, 90 degrees apart around outer edges of coupling halves.

3.1.5.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.001 inch tolerance, except as other-wise required by more stringent requirements of equipment manufacturer.

3.2 POSTED OPERATING INSTRUCTIONS

For each designated system or equipment item, provide instructions for guidance of operating and maintenance personnel. Following approval of content, prepare these instructions in a form and scale that will be readily legible when displayed in appropriate locations, to be designated by the Contracting Officer and meet the following requirements:

3.2.1 Each System

For each system, include diagrams of equipment, piping, wiring and control. Define control sequences.

3.2.2 Each Item

For each equipment item, include starting, adjustment, operation, lubrication, safety precautions and shut-down procedures. Identify procedures to be performed in event of equipment failure. Provide other instructions recommended by the manufacturer.

3.2.3 Diagrams

The Contractor shall provide a professionally prepared isometric piping diagram of the fueling system apparatus. Diagram shall be 36 inches x 54 inches and shall be color coded to match PCP color diagrams. Diagram shall show the entire facility and shall include all equipment and the operational sequences of all equipment with equipment numbers displayed. Diagram shall show all valves along with the valve numbers shown on the drawings and listed as normally open/closed. It shall be wall mounted under glass.

3.3 Equipment Tests

Following the completion of the Initial System Adjustments, but prior to the system performance tests, the following equipment tests shall be performed.

3.3.1 Fuel Delivery

Flow rates at each offload station shall be measured against various suction restrictions . Each flow rate period shall be at least 1 minute. False restrictions shall be created by throttling a valve upstream of the air eliminator . The valve may be located on a tank truck or in the pipe . The corresponding flow rates \~(GPM)~\ shall be recorded.

3.3.2 Pump Operation

Operation to start and stop the pumps rates shall be demonstrated in the presence of the Contracting Officer. The operating sequence shall be repeated with each of the pumps being selected. For this test, the flow rates shall be measured and recorded.

3.3.3 Emergency Shutdown

With one pump running, each emergency stop pushbutton station shall be tested to verify that the pump stops at the pushbutton station. The above procedure shall be repeated for each pump.

3.4 System Performance Tests

Testing as performed under paragraph Equipment Tests shall be performed again and shall be considered the initial system performance test. The initial test shall be performed following necessary system adjustments and calibrations to the various equipment and controls. The initial performance test shall also demonstrate the proper operation of each flushing mode. Following the initial performance test, a final performance test shall be performed which involves the demonstration of the system during actual truck offloading. The maximum rated capacity of the system shall be tested by using several trucks simultaneously. In the event a portion of the system or any piece of equipment fails to meet the test, the Contractor shall make the necessary repairs or adjustments and repeat the performance tests until satisfactory performance is obtained.

3.5 FLUSHING, CLEANING, AND ADJUSTING

3.5.1 Preparations for Flushing

Following installation but prior to equipment tests, the following preparations for flushing the system shall be performed.

3.5.1.1 Initial System Cleaning

Preservatives and foreign matter within the piping, valves, line strainers, pumps, oil/water separators and other equipment coming in contact with fuel shall be removed. Fuel will not be delivered to the system until the initial system cleaning is satisfactorily completed and approved by the Contracting Officer.

3.5.1.2 Protection of Equipment

Control valves and fuel sensors shall be removed from the system prior to the start of flushing operations and, where applicable, replaced with spools of pipe whose diameter is equal to the item removed. Coalescer and separator elements in each existing filter separator shall also be removed prior to the flushing operations.

3.5.1.3 Temporary Strainers

Temporary 40 mesh cone type strainers shall be installed in the suction line ahead ofthe connection to the existing piping or at the entrance to the pumohouse. The temporary strainers shall remain in place for a minimum of 2 days after system startup, after which time the Contractor shall remove the strainers and prepare the piping as intended for final system operation.

3.5.2 System Flushing

Flushing procedures shall precede fuel cleaning procedures.

3.5.2.1 Procedures

The entire new fuel piping system shall be flushed with fuel. The flow rate of the system during flushing procedures shall gradually be increased up to

and held at the maximum rated system capacity. Strainers shall be kept clean in order to ensure maximum flow rate.

3.5.2.2 Flushing Acceptance

Acceptance of the flushing procedure shall be based on the fuel having a maximum of \^2.1 mg/L^\ \~8.0 milligrams per gallon~\ solids with free water not to exceed \^2.1 mL/L.^\ \~2 milliliters per quart.~\ If the sample tested exceeds the maximum contamination allowances, the system flushing procedure shall be repeated at the Contractor's expense.

3.5.3 Fuel Cleaning

Following the acceptance of the flushing procedures, temporary strainers shall be removed and piping spools replaced with the appropriate equipment. Fuel sensors, meters, pressure indicating transmitters, and coalescer and separator elements in filter separators shall be reinstalled. Permanent strainers shall be removed, cleaned, and reinstalled. If the pressure differential across the filter/separator elements exceed that recommended by the manufacturer, the elements shall be replaced at the contractors expense.

3.5.3.1 Procedures

The cleaning procedure shall be performed by continually circulating fuel through the entire new fueling system. The flow rate of the fuel cleaning procedure shall gradually be increased up to the maximum rated system capacity. The cleaning procedure shall continue until the following acceptance certification is met.

3.5.3.2 Cleaning Acceptance

Acceptance of the fuel cleaning procedure will be based on the certification from the Contracting Officer that each fuel sample has a maximum contamination level of \~2.0 milligrams per gallon~\ solids with free water not to exceed 10 parts per million.

3.5.4 Initial System Adjustments

Following the flushing and cleaning operations but prior to equipment tests, each system component shall be initially adjusted, if necessary, to meet the system's final operational requirements. The Government will supply enough fuel to the system to enable the Contractor to make final adjustments to equipment and controls. Flow rates and pressures shall be adjusted to meet the indicated requirements. Pumps, control valves, filter separators, etc. shall operate as intended. The sequence of control for each component shall be adjusted to meet the indicated system requirements. Following the initial system adjustments, the equipment tests shall be performed in order to determine any necessary final system adjustments.

3.6 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 2 hours of normal working time and shall start after the system is functionally completed but prior to final system acceptance. The field

instructions shall cover all of the items contained in the operation and maintenance manuals as well as demonstrations of routine maintenance operations.

SECTION 15060

PIPE, MANUAL VALVES, AND FITTINGS, FUELING SYSTEM

SECTION 15060

PIPE, MANUAL VALVES, AND FITTINGS, FUELING SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI Z49.1-\	(1988) Safety in Welding and Cutting

AMERICAN PETROLEUM INSTITUTE (API)

\-API SPEC 5L-\	(1995) Line Pipe
\-API SPEC 6D-\	(1994) Pipeline Valves (Gate, Plug, Ball, and Check Valves)
\-API RP 6FA-\	(1994; R 1990; Supple) Fire Test for Valves
\-API STD 607-\	(1993) Fire Test for Soft-Seated Quarter-Turn Valves
\-API STD 608-\	(1995) Ball Valves
\-API RP 1110-\	(1991) Pressure Testing of Liquid Petroleum Pipeline

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME-16-\	(1992; Addenda Dec 1992, Dec 1992, Dec 1994) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels DIVISION 1
\-ASME-17-\	(1992; Addenda Dec 1992, Dec 1993, Dec 1994) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
\-ASME B1.1-\	(1989) Unified Inch Screw Threads (UN and UNR Thread Form)
\-ASME B16.5-\	(1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
\-ASME B16.9-\	(1993) Factory-Made Wrought Steel Buttwelding Fittings

\-ASME B16.11-\	(1991) Forged Fittings, Socket-Welding and Threaded
\-ASME B16.21-\	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
\-ASME B18.2.1-\	(1981; R 1992) Square and Hex Bolts and Screws Inch Series
\-ASME B18.2.2-\	(1987) Square and Hex Nuts (Inch Series)
\-ASME B31.1-\	(1995) Power Piping
\-ASME B31.3-\	(1990; B31.3a-1990; Errata; B31.3b-1991) Chemical Plant and Petroleum Refinery Piping

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

\-ASTM A53-\	(1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
\-ASTM A105-\	(1996) Forgings, Carbon Steel, for Piping Components
\-ASTM A181-\	(1995b) Carbon Steel Forgings, for General Purpose Piping
\-ASTM A182-\	(1996e) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
\-ASTM A193-\	(1996b) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
\-ASTM A194-\	(1996) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
\-ASTM A234-\	(1996a) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
\-ASTM D229-\	(1991) Rigid Sheet and Plate Materials Used for Electrical Insulation
\-ASTM E94-\	(1991) Radiographic Testing
\-ASTM F436-\	(1991) Hardened Steel Washers

AMERICAN WELDING SOCIETY (AWS)

\-AWS A2.4-\	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination

\-AWS A3.0-\	(1989) Welding Terms and Definitions Including Terms for Brazing, Soldering, Thermal Spraying and Thermal Cutting
\-AWS A5.1-\	(1991) Carbon Steel Electrodes for Shielded Metal Arc Welding
\-AWS A5.4-\	(1981) Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Electrodes
\-AWS A5.5-\	(1981) Low-Alloy Steel Covered Arc Welding Electrodes

COMMERCIAL ITEM DESCRIPTION (CID)

\-A-A-52554-\	(1996) Hose and Hose Assemblies, Nonmetalic, Elastomeric, Liquid Fuel

FEDERAL SPECIFICATIONS (FS)

\-FS L-C-530-\	(Rev C) Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
\-FS L-T-1512-\	(Rev A; Reinst) Tape, Pressure Sensitive Adhesive, Pipe Wrapping

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE C62.41-\	(1991) Surge Voltages in Low-Voltage AC Power Circuits

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

\-MSS SP-58-\	(1988) Pipe Hangers and Supports-Materials, Design and Manufacture
\-MSS SP-69-\	(1991) Pipe Hangers and Supports-Selection and Application

MILITARY SPECIFICATIONS (MS)

\-MS MIL-C-4556-\	(Rev E) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
\-MS MIL-H-370-\	(Rev F) Hoses and Hose Assemblies, Nonmetallic,Rubber, Liquid Fuel
\-MS MIL-V-12003-\	(Rev F; Am 1) Valves Plug: Cast Iron or Steel, Manually Operated
\-MS MIL-S-13789-\	(Rev D) Strainers, Sediment: Pipeline, Basket Type
\-MS MIL-P-24441-\	Paint, Epoxy-Polyamide, General Specification for Paint, Epoxy-Polyamide

MILITARY STANDARDS (MIL-STD)

\-MIL-STD-161-\	(Rev F; Notice 2) Bulk Petroleum Products System Including Hydrocarbon Missile Fuels
\-MIL-STD-271-\	(Rev F) Nondestructive Testing Methods

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 30-\	(1990) Flammable and Combustible Liquids Code

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

\-SAE J 514-\	(1989) Hydraulic Tube Fittings, Standard

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

\-SSPC SP 5-\	(1991) White Metal Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

\-UL 1449-\	(1996) Transient Voltage Surge Suppressors

1.2 SUBMITTALS

In accordance with the Section 01330, the Contractor shall submit for approval the following items required by this section.

SD-01 Data\

Piping\; *GA*\.

Fittings\; *GA*\.

Valves\; *GA*\.

Strainers\; *GA*\.

Flexible Hoses\; *GA*\.

Lightning Surge Arrester\; *GA*\.

(Coating)

Sample Connections\; *GA*\.

Isolating Gasket Kits\; *GA*\.

Gaskets\; *GA*\.

Purge Blocks\; *GA*\.

Manufacturer's Catalog Data

SD-08 Statements\

Qualifications of Welders\; *FIO*\.

SD-09 Reports\

Pneumatic Test\; *FIO*\.

Hydrostatic Test\; *FIO*\.

SD-13 Certificates\

Pipe\; *FIO*\.

Fittings\; *FIO*\.

Valves\; *FIO*\.

Pipe Weld Radiograph Inspector's Certification\; *FIO*\ (for field welds).

Epoxy Coating and Application\; *FIO*\.

Isolating Gasket Kits\; *FIO*\.

SD-19 Operation and Maintenance Manuals\

Operation and Maintenance Manuals\; *GA*\.

Operation and maintenance information shall be submitted for the equipment items or systems listed below.

Manual Valves
Strainers
Sample Connections
Isolating Gasket Kits
Gaskets
Flexible Hoses

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Design conditions shall be as specified in Section \=15050=\ MECHANICAL EQUIPMENT, FUELING SYSTEM.

2.2 MATERIALS

2.2.1 General

Pipe and fittings in contact with fuel shall be carbon steel. No zinc coated metals, brass, bronze or other copper bearing alloys shall be used in contact with the fuel. Identification of piping shall be in accordance with \-MIL-STD-161-\ unless specified otherwise. Material for manual valves shall be as specified hereinafter.

2.2.2 Carbon Steel Piping

Each length of pipe shall be subjected to hydrostatic testing and ultrasonic testing in accordance with their respective pipe specification.

a. Piping 12-Inches and Larger: Seamless, ASTM A53 Grade B having a wall thickness of 0.375-inch.

b. Piping 2 1/2-Inches through 10-Inches: Seamless, Schedule 40 API SPEC 5L Grade B or ASTM A53 Grade B.

c. Piping Two-Inches and Smaller: Seamless, Schedule 80 API SPEC 5L Grade B or ASTM A53 Grade B.

d. Welding Electrodes: E70XX low hydrogen electrodes conforming to \-AWS A5.1-\ or \-AWS A5.5-\.

2.2.3 Protective Coatings for Aboveground Carbon Steel Piping

Provide painting of aboveground piping, piping in pits, pipe supports, air eliminators, and miscellaneous metal and equipment in accordance with MIL-P-24441. Color of finish coat shall be white. Do not paint stainless steel or aluminum surfaces.

2.2.4 Fittings

2.2.4.1 General

Welding ells, caps, tees, reducers, etc., to be of materials compatible for welding to the pipe line in which they are installed, and wall thickness, pressure and temperature ratings of the fittings shall be not less than the adjoining pipe line. Unless otherwise required by the conditions of installation, all elbows shall be the long radius type. Miter joints shall not be acceptable. Make odd angle offsets with pipe bends or elbows cut to the proper angle. Butt weld fittings to be factory-made wrought fittings manufactured by forging or shaping. Fabricated fittings will not be permitted.

2.2.4.2 Carbon Steel Fittings

a. Fittings 2 1/2 Inches and Larger: Butt weld, conforming to \-ASTM A234-\, grade WPB and \-ASME B16.9-\ of the same wall thickness as the adjoining pipe. All welds shall be radiographically examined throughout the entire length of each weld. Each fitting shall be subjected to the Supplementary Requirements S3 and S4, Liquid Penetration examination and Magnetis-Particle Examination. Detectable flaws will not be accepted in the supplementary examinations. Fittings shall be identified to relate them to their respective radiograph.

b. Fittings 2 Inches and Smaller. Forged (socket welded or if indicated on drawings, threaded), 2,000-pound W.O.G., conforming to \-ASTM A105-\, Grade 2 and \-ASME B16.11-\. Threaded fittings shall only be used for above grade applications.

c. Flanges: One-hundred-fifty-pound weld neck, forged flanges conforming to \-ASTM A181-\, Grade 2, and \-ASME B16.5-\. Flanges to be 1/16-inch raised face with phonographic finish, except where required otherwise to match equipment furnished. Match flange face to valves or equipment

furnished. Flange face shall be machined to match valves or equipment furnished. Use of spacing rings or gaskets discs are not allowed. Flanges shall be subjected to the Supplementary Requirements S4 and S5, Liquid Penetrant Examination, and Magnetic-Particle Examination. Detectable flaws will not be accepted.

2.2.4.3 Isolating Gasket Kits (Insulating) for Flanges

Provide \-ASTM D229-\ electrical insulating material of 1,000 ohms minimum resistance; material shall be resistant to the effects of aviation hydrocarbon fuels. Provide full face insulating gaskets between flanges. Provide full surface 0.03-inch thick wall thickness, spiral-wound mylar insulating sleeves between the bolts and the holes in flanges; bolts may have reduced shanks of a diameter not less than the diameter at the root of threads. Provide 0.125-inch thick high-strength phenolic insulating washers next to flanges and provide flat circular stainless steel washers over insulating washers and under bolt heads and nuts. Provide bolts 0.5-inch longer than standard length to compensate for the thicker insulating gaskets and the washers under bolt heads and nuts. Exterior above grade flanges separated by electrically isolating gasket kits shall be provided with weatherproof lightning surge arrester devices. The surge arrester shall bolt across flanges separated by insulating gasket kits per detail on contract drawings. The arrestor shall have the following features:

a. Weatherproof NEMA 4 enclosure.
b. Bidirectional and bipolar protection.
c. Constructed of solid state components, no lights, fuses or relays shall be used that will require maintenance or replacement.
d. Withstand unlimited number of surges at 50,000 Amperes.
e. Maximum clamping voltage of 700 Volts based on a \-IEEE C62.41-\ 8x20 mircosecond wave form at 50,000 Amperes peak measured at the device terminals (zero lead length).

Install the mounting bracket and leads on the flange side of the bolt insulating sleeve and washer, and size in accordance with this schedule.

Line Size (Inches)	Bolt Size (Inches)
2	5/8
2-1/2	5/8
3	5/8
4	5/8
6	3/4
8	3/4
10	7/8
12	7/8
14	1
16	1

(Note: Allowance must be made for the 1/32-inch thickness of the insulating sleeve around the bolts when sizing the mounting lugs.)

2.2.5 Bolts and Nuts

Bolts and nuts for pipe flanges, flanged fittings, valves and accessories shall conform to \-ASME B18.2.1-\ and \-ASME B18.2.2-\, except as otherwise specified. Bolts shall be of sufficient length to obtain full bearing on the nuts and shall project no more than two full threads beyond the nuts with the bolts tightened to the required torque. Bolts shall be regular hexagonal bolts conforming to ASME B18.2.1 with material conforming to \-ASTM A193-\, Class 2, Grade B8. Bolts shall be threaded in accordance with \-ASME B1.1-\, Class 2A fit, Coarse Thread Series, for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch. Nuts shall conform to \-ASME B18.2.2-\, hexagonal, heavy series with material conforming to \-ASTM A194-\, Grade 8. Nuts shall be threaded in accordance with \-ASME B1.1-\, Class 2B fit, Coarse Thread Series for sizes one inch and smaller and Eight-Pitch Thread Series for sizes larger than one inch. Provide washers under bolt heads and nuts. Washers to be \-ASTM F436-\, flat circular stainless steel. Torque wrenches shall be used to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tightening pattern shall be as recommended by the gasket manufacturer.

2.2.6 Gaskets

\-ASME B16.21-\, composition ring 0.1250-inch thick. Gaskets shall be resistant to the effects of aviation hydrocarbon fuels and manufactured of fire-resistant materials. Full-face gaskets shall be used for flat-face flanged joints. Ring gaskets shall be used for raised-face flanged joints. Gaskets shall be of one piece factory cut.

2.2.7 Relief and Drain System Piping

Pressure relief valve discharge lines and drain lines shall be Schedule 40 \-API SPEC 5L-\ Grade B or \-ASTM A53-\ Grade B Carbon Steel.

2.2.7.1 Gaskets

See Gaskets specified hereinbefore.

2.2.8 Relief and Drain System Protective Coating

Pipe shall be coated as specified hereinbefore for steel piping.

2.2.9 Threaded Joints

Threaded joints, if indicated on the drawings, shall be made tight with manufacturer recommended teflon tape or a mixture of graphite and oil, inert filler and oil, or with a graphite compound, applied with a brush to the male threads. Not more than three threads shall show on made up joints. Threaded joints, mechanical couplings and flanges will not be permitted in buried piping. Threaded joints shall not get welded.

2.2.10 Welded Joints

Welded joints in steel pipe shall be as specified in Part 3 "EXECUTION."

2.3 MANUAL VALVES

Stem and trim shall be stainless steel for all valves. Manually operated valves six inches and larger shall be worm-gear operated and valves smaller than six inches shall be wrench operated. Valves smaller than two inches shall have lever-type handles.

2.3.1 Ball Valves

Ball valves shall be fire tested and qualified in accordance with the requirements of \-API STD 607-\ and \-API STD 608-\. Ball valves shall be nonlubricated valves that operate from fully open to fully closed with 90 degree rotation of the ball. Valves two inches and larger shall conform to applicable construction and dimension requirements of \-API SPEC 6D-\, ANSI Class 150 and shall have flanged ends. Valves smaller than 2 inches shall be ANSI class 150 valves with one piece bodies with flanged ends, unless noted otherwise. The balls in valves 10 inches and larger shall have trunion type support bearings. Except as otherwise specified, reduced port or full port valves may be provided at the Contractor's option.

2.3.1.1 Materials

Ball shall be stainless steel. Ball valves shall have tetraflouroethylene (TFE) or Viton seats, body seals and stem seals.

2.3.2 Plug (Double Block and Bleed) Valves

\-API SPEC 6D-\ and \-MS MIL-V-12003-\ Type III, ANSI Class 150, non-lubricated, resilient, double seated, trunion mounted, tapered lift plug capable of two-way shutoff. Valve shall have stainless steel or carbon steel body with chrome-plated interior, tapered plug of steel or ductile iron with chrome or nickel plating and plug supported on upper and lower trunions. Sealing slips shall be steel or ductile iron, with Viton seals which are held in place by dovetail connections. Valve design shall permit sealing slips to be replaced from the bottom with the valve mounted in the piping. Valves shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves shall have weatherproof operators with mechanical position indicators. Minimum bore size shall be not less than 65 percent of the internal cross sectional area of a pipe of the same nominal diameter unless bore height of plug equals the nominal pipe diameter and manufacturer can show equal or better flow characteristics of the reduced bore size design.

2.3.2.1 Valve Operation

Rotation of the handwheel toward open shall lift the plug without wiping the seals and retract the sealing slips so that during rotation of the plug clearance is maintained between the sealing slips and the valve body. Rotation of the handwheel toward closed shall lower the plug after the sealing slips are aligned with the valve body and force the sealing slips against the valve body for positive closure. When valve is closed, the slips shall form a secondary fire-safe metal-to-metal seat on both sides of the resilient seal. Plug valves located in Isolation Valve Pits shall be provided with handwheel extensions.

2.3.2.2 Relief Valves

ANSI Class 150. Provide plug valves with automatic thermal relief valves to relieve the pressure build up in the internal body cavity when the plug valve is closed. Relief valves shall open at 25 psi differential pressure and shall discharge to the throat of, and to the side of the plug valve as indicated on the drawings.

2.3.2.3 Bleed Valves

ANSI Class 150, stainless steel body valve. Provide manually operated bleed valves that can be opened to verify that the plug valves are not leaking when in the closed position.

2.4 RELIEF VALVES

Relief valves shall be the fully enclosed, spring loaded, angle pattern, single port, hydraulically operated type with plain caps, and shall be labeled in accordance with \-ASME-16-\. Valve stems shall be fully guided between the closed and fully opened positions. The valves shall be factory-set to open at the set pressure indicated on the drawings. Operating pressure shall be adjustable by means of an enclosed adjusting screw. The valves shall have a minimum capacity of 20 GPM at 10 percent overpressure and shall operate at rated capacity with a back pressure not exceeding 50 psi. Valves shall have a replaceable seat.

2.4.1 Materials

Valves shall have carbon steel bodies and bonnets with stainless steel springs and trim. Valves shall be Class 150 flanged end connections.

2.4.2 Sight Flow Indicators

Sight flow indicators shall be ANSI Class 150 and shall have flanged end connections. Sight flow indicators shall consist of a housing containing a rotating propeller that is visible through a glass observation port. The housing shall be carbon steel. The glass in the indicator shall also meet the Class 150 rating.

2.5 PIPING ACCESSORIES

2.5.1 Strainers

2.5.1.1 Basket Type

Strainer shall be in compliance with \-MS MIL-S-13789-\, except as specified otherwise. Strainer end connections shall be designed in accordance with \-ASME B16.5-\, Class 150. Strainers shall have stainless steel bodies, stainless steel shall be Types 304 or 316. Strainers shall have removable baskets of 60 mesh wire screen with larger wire mesh reinforcement; wire shall be stainless steel, Type 316. Pressure drop for clean strainer shall not exceed three psig at design flow rate. The ratio of net effective strainer area to the area of the connecting pipe shall be not less than three to one. Each strainer shall be provided with a suitable drain at the bottom, equipped with a ball valve. Strainer shall be the single inlet, single outlet design. Strainer shall be supplied with a piston type direct reading differential pressure gage .

2.5.1.2 Cone Type (Temporary)

Strainer shall be stainless steel type 304 or 316, 60 mesh screen with the ratio of net open area of strainer to the area of the connecting pipe shall be not less than one to one.

2.5.2 Pipe Hangers and Supports

2.5.2.1 General

Pipe hangers and supports shall conform to \-MSS SP-58-\ and \-MSS SP-69-\. Supports shall be provided at the indicated locations. Support channels for drain lines shall be epoxy coated on all surfaces or hot-dip galvanized after the channels are cut to length. Coated supports shall be coated with fusion bonded epoxy resin applied by the fluidized bed method. Thickness of the coating shall be not less than 10 mils. Surface preparation and coating application shall be in accordance with the epoxy manufacturer's instructions. The coating shall be pinhole free when tested with a low voltage holiday detector set at no more than 100 times the mil thickness of the coating. All pinholes shall be marked, repaired and retested to ensure a pinhole free film. The coating material shall be a 100 percent solids, thermosetting, fusion-bonded, dry powder epoxy resin. The manufacturer shall certify that the material is suitable for fluidized bed application and that it is approved by the Environmental Protection Administration.

2.5.2.2 Adjustable Pipe Supports

Adjustable pipe supports shall consist of a cast iron saddle and a threaded nipple connected to a carbon steel pipe by means of a special reducer conforming to \-MSS SP-69-\. The supports shall be provided with neoprene insulation strips.

2.5.2.3 Low Friction Supports

Low friction supports shall be self-lubricating antifriction element composed of reinforced TFE. Units shall be factory designed and manufactured.

2.5.2.4 Concrete and Grout

Concrete and grout for anchors and supports shall comply with \=SECTION 03300A=\ CONCRETE FOR BUILDING CONSTRUCTION.

2.5.3 Sample Connections

Sample connections shall be factory assembled units specifically designed for obtaining representative samples from fuel pipelines. Each connection shall include a 1/4-inch sampling probe where the probe faces upstream, ball valve and 1/4-inch quick disconnect coupling with dust plug, all assembled into a unit that is suitable for installation in a pipe nipple. The sampling probe shall extend not less than one inch into the fuel pipe. All materials in the sample connections shall be stainless steel or aluminum.

2.5.3.1 Sampling Hoses

Furnish two sampling hose assemblies to the Contracting Officer at the project site. Each assembly shall consist of a six-foot length of 1/4-inch clear plastic tubing with internal bonding/grounding wire. One end of the tubing will contain a male connector that actuates flow when inserted into the quick disconnect coupler. Each end of the bonding/grounding wire shall be equipped with clips for attaching to the pipe and metal sample container.

2.5.4 Fuel Hose

The offload fuel hose shall be 4-inch, lightweight, flexible, non-pressurized offloading hose constructed of nitrile rubber, rigid PVC helix, synthetic braiding, smooth bore, corrugated outer diameter, and shall conform to \-CID A-A-52554(formerly MIL-H-370), non-collaspible, threaded, male NPT, both ends, and have UV protection.

2.6 FLEXIBLE HOSES

Flexible hoses for fueling pumps shall have ANSI Class 300 flanges of stainless steel construction conforming to \-ASME B16.5-\. Flexible hoses shall be of stainless steel flexible metal hose consisting of an inner corrugated stainless steel tube with stainless steel braid cover. All components to be suitable for not less than 275 psig. Length and application of flexible hoses shall be per manufacturer's written recommendations.

PART 3 EXECUTION

3.1 WELDING

3.1.1 General

All joints unless indicated otherwise, shall be welded. Unless otherwise approved, all girth welds shall be complete penetration groove welds made in accordance with qualified welding procedures. Welding operations, qualifications of welders and welding procedures shall comply with the provisions of \-ASME B31.3-\ and the requirements specified herein. The root pass on carbon steel pipe shall be by MIG or TIG.

a. Definitions shall be in accordance with \-AWS A3.0-\.

b. Symbols shall be in accordance with \-AWS A2.4-\ for welding and nondestructive testing, unless otherwise indicated.

c. Safety Precautions shall conform to \-ANSI Z49.1-\.

d. Weld Preparation shall comply with the requirements of \-ASME B31.3-\ and the qualified Welding Procedure Specification. The use of "rice paper" as

purge blocks is not permitted. Contractor shall submit alternate method for approval.

e. Backing Rings. The use of backing rings for making or repairing welds will not be permitted.

3.1.2 Qualifications of Welders

Welders and welding procedures shall be qualified in accordance with requirements of \-ASME B31.3-\.

3.1.2.1 Weld Identification

Each qualified welder shall be assigned an identification symbol. All welds shall be permanently marked with the symbol of the individual who made the weld.

3.1.2.2 Defective Work

Welders found making defective welds shall be removed from the work or shall be required to be requalified in accordance with \-ASME B31.3-\.

3.1.3 Tests

All field welds shall be examined by radiographic methods to determine conformance to the paragraph "Standards of Acceptance." The services of a qualified commercial or testing laboratory approved by the Contracting Officer shall be employed by the Contractor for testing of piping welds. Costs of testing, including retesting or repaired welds, shall be borne by the Contractor.

3.1.3.1 Radiographic Inspection

Procedures for radiographic inspection shall be in accordance with \-MIL-STD-271-\ or \-ASTM E94-\. Weld ripples or surface irregularities that might mask or be confused with the radiographic image of any objectional defect shall be removed by grinding or other suitable mechanical means. The weld surface shall be merged smoothly with the base metal surface.

3.1.4 Standards of Acceptance

Interpretation of test results and limitations on imperfections in welds shall comply with the requirements for "100 percent Radiography, per \-ASME B31.3-\, Chapter VII, Table K341.3.2A.

3.1.5 Corrections and Repairs

Defects shall be repaired in accordance with approved procedures. Defects discovered between passes shall be repaired before additional weld material is deposited. Whenever a defect is removed and repair by welding is not required, the affected area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners. After a defect is thought to have been removed, and prior to rewelding, the area shall be examined by suitable methods to insure that the defect has been eliminated. After repairs have been made, the repaired area shall be reinspected and shall meet the standards of acceptance for the original weld. Any indication of a defect

shall be regarded as a defect unless reevaluation by nondestructive methods and/or by surface conditioning shows that no defect is present.

3.1.5.1 Defect Removal

Defective or unsound weld joints shall be corrected by removing and replacing the entire weld joint, or for the following defects corrections shall be made as follows:

a. Excessive Convexity and Overlap: Reduce by removal of excess metal.

b. Excessive Concavity of Weld, Undersized Welds, Undercutting: Clean and deposit additional weld metal.

c. Excessive Weld Porosity, Inclusions, Lack of Fusion, Incomplete Penetration: Remove defective portions and reweld.

d. Crack in Weld or Base Metal: Remove crack throughout its length, including sound weld metal for a distance of twice the thickness of the base metal or two inches, whichever is less, beyond each end of the crack, followed by the required rewelding. Complete removal shall be confirmed by magnetic particle inspection for carbon steel or liquid penetrant inspection for stainless steel. Inspection procedures shall comply with the requirements of \-ASME B31.3-\.

e. Poor Fit-Up: Cut apart improperly fitted parts, and reweld.

3.1.5.2 Methods of Defect Removal

The removal of weld metal or portions of the base metal shall be done preferably by chipping, grinding, sawing, machining, or other mechanical means. Defects also may be removed by thermal cutting techniques. If thermal cutting techniques are used, the cut surfaces shall be cleaned and smoothed by mechanical means.

3.1.5.3 Rewelding

Repair welds shall be made using an electrode or filler wire preferably smaller than that used in making the original weld. Rewelding shall be done using qualified welding procedures. The surface shall be cleaned before rewelding. Repair welds shall meet the requirements of this specification.

3.1.5.4 Peening or Caulking

The use of force (peening) or foreign materials to mask, fill in, seal, or disguise any welding defects shall not be permitted.

3.2 INSTALLATION

3.2.1 Precautions

Special care shall be taken by the Contractor to insure that the completed system is free of rocks, sand, dirt, and foreign objects. The Contractor shall take the following steps to insure these conditions.

a. Pipe brought to the site shall be stored on blocks or horses at least 18 inches above the ground. Padded blocks or horses shall be used for coated pipe. The method and height of storing coated pipe shall be in accordance with the coating manufacturer's instructions.

b. Visual inspection shall be made of the inside of each length of pipe to ensure that it is clear and clean prior to installation.

c. The open ends of the pipe system shall be closed at the end of each day's work or when work is not in progress and shall not be opened until the work is resumed.

d. A swab, with a leather or canvas belt disc to fit the inside diameter of pipe, shall be pulled through each length of pipe after welding in place.

e. Obstruction remaining in the pipe after completion of the system shall be removed at the expense of the Contractor.

3.3 VERIFICATION OF DIMENSIONS

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

3.4 CLEANING OF PIPING

The Contractor shall keep the interior and ends of all new piping affected by the Contractor's operations thoroughly cleaned of foreign matter and water before and after being installed. Piping systems shall be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of piping and fittings shall be closed so that no water or other foreign substance will enter the pipes or fittings. Piping shall be inspected before placing into position. The interior of each length of pipe shall be cleaned after welding. It shall be the Contractor's responsibility for insuring that the interior of the piping is free of foreign matter when it is connected into the system.

3.5 PIPING LAYOUT REQUIREMENTS

3.5.1 Pipe Fabrication

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system.

3.5.2 Interferences and Measurements

Provide offsets, fittings, and accessories required to eliminate interferences and to match actual equipment connection locations and arrangements. Verify measurements before commencing work. Submit discrepancies for clarification before proceeding with the installations to the Contracting Officer.

3.5.3 Space and Access

Keep piping, control tubing, which is not detailed close to structures and columns so as to take up a minimum amount of space. Ensure that access is provided for maintenance of equipment, valves and gauges.

3.5.4 Location

Do not place unions in locations that will be inaccessible after the completion of the work. Place unions on each side of equipment.

3.5.5 Piping and Equipment

Provide anchors where required to absorb or transmit thrust or eliminate vibration or pulsation. Provide hangers and supports near each change of direction. Select support components which do not restrict the movement of the pipe due to thermal expansion. Space hangers uniformly and arrange symmetrically.

3.5.6 Structural Support

Provide supplementary or intermediate steel or other structural members as required for transmission of loads to members forming part of the supporting structure.

3.5.7 Grade

Where profiles of piping lines are shown on the drawings, grade the line uniformly between changes in slope or direction. Maintain gradient to within ± 1/4-inch over the entire length of pipe.

3.5.8 Size Changes

Make changes in pipe size with reducing fittings. Do not use bushings. In lieu of welding reducing outlet tees for piping 2 inches and larger, welding branches suitable for 100 percent radiographic inspection may be used. Do not use weldolets unless specifically called out (labeled) on the drawings.

3.5.9 Direction Changes

Make changes in the horizontal direction of pipes with long radius fittings. Provide special fittings when required. Do not make miter welds. Make odd-angle offsets with pipe bends or elbows cut to the proper angle.

3.6 TESTING

Piping shall be tested by pneumatic and hydrostatic pressure. Testing shall comply with applicable requirements of \-ASME B31.3-\, \-NFPA 30-\ and the requirements specified herein. Hydrostatic testing shall be performed using fuel as the liquid. Water shall not be introduced into the system for testing. Pressure and hydrostatic testing shall be performed only after welding inspection has been completed.

3.6.1 General

Piping to be installed underground shall not receive field applied protective covering at the joints or be covered by backfill until the piping has passed the pneumatic test described herein. To facilitate the tests, the Contractor

shall isolate various sections of the piping system and test each one separately. Where such sections terminate at flanged valve points, the line shall be closed by means of blind flanges in lieu of relying on the valve. The Contractor shall furnish tapped flanges that can be attached to the end of the section of line being tested, and that will permit a direct connection between the piping and the air compressor and/or pressurizing pump. No taps in the permanent line will be permitted. The Contractor shall furnish all necessary equipment for testing; all gauges shall be subject to testing and approval of the Contracting Officer. The air used for pneumatic testing shall have a residual humidity of not over 20 percent. The Contractor shall provide dehumidifying equipment on the suction or discharge side of the air compressor used to provide air for testing. Pressurizing pump shall not exceed 10 cfm.

3.6.1.1 Pneumatic Test Procedure

Special safety measures, including the wearing of face mask, shall be taken during testing under pressure. Only authorized personnel shall be permitted in the area during testing. The pneumatic test pressure shall be applied in increments. A preliminary 25 psig test shall be applied. Examine joints with soap solution. Leaks revealed by this test shall be repaired. The full test pressure shall then be applied. Unless otherwise directed by the Contracting Officer, all piping shall be tested at a pressure of 50 psig for not less than 2 hours, during which time there shall be no drop in pressure, only pressure rises with temperature. The pressure source shall be disconnected during the final test period. Any leaks revealed by the test shall be repaired and the test repeated.

3.6.1.2 Hydrostatic Test Procedure

Upon completion of pneumatic testing and after backfilling, hydrostatically test each piping system with fuel at 200 psig in accordance with \-ASME B31.3-\ and \-API RP 1110-\, with no leakage or reduction in gauge pressure for four hours. The Contractor shall furnish electricity, instruments, connecting devices, and personnel for test. Fuel shall be furnished by the Government. Defects in work provided by the Contractor shall be corrected by him at his own expense, and the test repeated until the work is proven to be in compliance with the Contract requirements.

3.6.2 Performance Testing

The completed fuel system shall be cleaned and performance tested as specified in Section \=15050=\ MECHANICAL EQUIPMENT, FUELING. All control valves, both manual and automatic, shall be checked for leaks (any area wetted with fuel) and proper operation and adjusted, repaired or replaced to correct any defects.

SECTION 15101

CONTROL VALVES, FUELING SYSTEM

SECTION 15101

CONTROL VALVES, FUELING SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME B16.5-\	(1988; Errata) Pipe Flanges and Flanged Fittings

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

\-ASTM A 194/A 194M-\	(1996) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High Temperature Service
\-ASTM A 216/A 216M-\	(1993) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
\-ASTM A 269-\	(1996) Seamless and Welded Austenitic Stainless Steel Tubing for General Service
\-ASTM A 320/A 320M-\	(1994a, R1995) Standard Specification for Alloy Steel Bolting Materials for Low-Temperature Service
\-ASTM A 743/A 743M-\	(1995) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
\-ASTM B 26/B 26M-\	(1992a) Standard Specification for Aluminum Alloy Sand Castings
\-ASTM D 751-\	(1989) Standard Test Method for Coated Fabrics
\-ASTM D 2000-\	(1990) Standard Classification System for Rubber Products in Automotive Applications

MILITARY SPECIFICATIONS (MS)

\-MS MIL-A-8625-\	(1989; Rev E, Am. 1) Anodic Coatings, for Aluminum and Aluminum Alloys
\-MS MIL-I-17563-\	(1985; Rev B) Impregnants for Aluminum, Copper, Iron, Magnesium and Zinc Alloy Castings

MILITARY STANDARDS (MIL-STD)

\-MIL-STD 276-\	(1956; Basic) Impregnation of Porous NonFerrous Metal Castings

NATIONAL FIRE PROTECTION AGENCY (NFPA)

\-NFPA 70-\	(1996) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

\-SAE J 200-\	(1991) Classification System for Rubber Materials
\-SAE J 429-\	(1983) Mechanical and Material Requirements for Externally Threaded Fasteners

1.2 AVAILABILITY

Control valves specified herein shall be of one manufacturer. The valve manufacturer shall also produce the hydraulically-operated pilots.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Control Valves\; *GA*\

For each type control valve required and specified, submit sectional drawings of main valve and control pilot systems.

SD-01 Data\

Control Valves\; *GA*\

For each type control valve required and specified, submit the following:

a. Flow diagrams.

b. Operational description of the control valve and pilot control system.

c. Complete valve assembly list of materials, along with material Certificates of Conformance, used in the manufacture of the control valves and pilot systems.

SD-13 Certificates\

Previous Air Force/Military Projects\; *GA*\

Qualified Engineers\; *GA*\

Field Assistance\; *GA*\

Provide the following:

a. Proof of experience on previous Air Force/Military projects.

b. Number of qualified (factory trained) engineers available to provide startup support.

c. Written assurance as to ability to respond to specified time for field assistance.

SD-09 Reports\

Control Valves\; *FIO*\

Before shipment, each individual control valve shall be operationally tested and adjusted by manufacturer under actual flow conditions utilizing a hydrocarbon test fluid with a specific gravity comparable to JP-8 fuel. Manufacturer shall submit certified records of test data.

SD-19 Operation and Maintenance Manuals\

Operation and Maintenance Manuals\; *GA*\

Operation and maintenance information shall be submitted for each individual type control valve specified herein.

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Shall be as specified in Section \=15050=\ MECHANICAL EQUIPMENT, FUELING. Components to be suitable for ANSI Class 150 (275 psig at 100 degrees F.).

2.2 CONTROL VALVE CONSTRUCTION

2.2.1 General

Control valves shall be single-seated globe type, diaphragm actuated, hydraulically operated valves. Valves shall consist of three (3) major components: the valve body, valve cover, and diaphragm assembly. The diaphragm assembly shall be the only moving part. In the event of diaphragm failure, valve shall fail closed against flow, unless otherwise indicated. The main valve shall be drip-tight when closed. Each valve shall have an external indicator to show the position of the valve disc at all times. Control valves shall be shipped from the factory as a complete assembly with all pilot controls and pilot auxiliary piping properly installed on the main valve. Materials which come in contact with the fuel shall be resistant to the effects of and not harmful to aircraft engine fuel and shall be aluminum or stainless steel unless noted otherwise. Materials for control valves, and items to be mounted on the valves shall be as follows:

2.2.1.1 Bodies, Bonnets, and Covers

Shall be constructed of one of the following materials:

a. Aluminum conforming to \-ASTM B 26/B 26M-\, Type 356-T6 anodized in accordance with \-MS MIL-A-8625-\, Type II and surface coated in accordance with \-MIL-STD 276-\/\-MS MIL-I-17563-\.

b. Cast steel conforming to \-ASTM A 216/A 216M-\, Grade WCB internally plated with chromium, nickel or internally electroless nickel plated.

c. Cast stainless steel conforming to \-ASTM A 743/A 743M-\.

d. Bodies shall have flanged inlet and outlet connections. Valve shall have a screwed bottom drain plug.

2.2.1.2 Valve Seats

Shall be stainless steel in accordance with \-ASTM A 743/A 743M-\. It shall be possible to remove the valve seat while the valve is connected in the line. Valve seat and upper stem bearing shall be removable and screwed in the body and/or cover. The lower stem bearing must be concentrically contained in the valve seat and shall be exposed to flow on all sides. The diameter of the valve seat shall be the same size as the inlet and/or outlet flanges of the main valve.

2.2.1.3 Valve Discs

Shall contain a resilient, synthetic rubber disc conforming to \-ASTM D 2000-\ (SAE J 30200) having a rectangular cross section, contained on three and one-half (3-1/2) sides by a disc retainer and a disc guide, forming a drip tight seal against the seat. The disc shall be usable on either side. The disc guide shall be the contoured type capable of holding disc firmly in place during high differential pressure conditions that may develop across the seating surface. The disc retainer shall be capable of withstanding rapid closing shocks.

2.2.1.4 Diaphragm Assembly

Shall form a sealed chamber in the upper portion of the valve, separating the operating fluid from the line pressure. The diaphragm assembly shall contain a valve stem which is fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. Valve body and cover shall be sealed by the diaphragm. Valve stem shall be stainless steel. The bearing material shall be compatible with the fuel specified and shall not contain zinc coated metals, brass, bronze, or other copper bearing alloys. The diaphragm shall be of a nonwicking material or design, with a minimum of two (2) layers of nylon fabric bonded with a minimum of three (3) layers of synthetic rubber (valves 2-1/2 inches and smaller one layer of nylon fabric). The edge area of the center hole for the valve stem shall be sealed by vulcanization. Materials to be resistant to aromatics of up to 50 percent in accordance with \-ASTM D 2000-\ (\-SAE J 200-\). The diaphragm must have a MULLINS-burst rating according to \-ASTM D 751-\ of a minimum of 600 psi per layer of nylon fabric. All diaphragm sizes must be cycle tested to a minimum of 100,000 cycles, by alternately applying pressure under the diaphragm (main valve pressure) and above the diaphragm (cover chamber pressure). That test shall be certified by the manufacturer. The diaphragm shall not be used as a seating surface. The diaphragm must be fully supported by the body and cover in either the open or closed position.

2.2.1.5 Bolts, Screws and Nuts

a. For Cast Aluminum and Cast Steel Body Valves.

(1) Bolts and Screws, cadmium plated steel in accordance with \-SAE J 429-\, Grade 5.

(2) Nuts, cadmium plated steel in accordance with \-ASTM A 194/A 194M-\, Grade 2 H.

b. For Stainless Steel Body Valves. Bolts, Screws and Nuts, \-ASTM A 320/A 320M-\, Grade B8M C.1.1.

2.2.1.6 Pilot Control System and Auxiliary Piping

Shall be stainless steel, seamless, fully annealed tubing conforming to \-ASTM A 269-\, Grade TP316, Rockwell hardness B80 or less. Wall thickness for 1/2-inch tubing to be 0.049-inch.. All screwed connections shall be made by conic unions (NPT). Tubing connections shall not be welded or sealed with O-ring.

2.2.1.7 Pilot Valves

Shall have stainless steel bodies conforming to \-ASTM A 743/A 743M-\ with stainless steel internal working parts. Disc and diaphragm assemblies shall be as specified herein before. The setting of adjustable type pressure operated pilot valves shall be easily adjusted by means of a single adjusting screw. The adjusting screw shall be protected by a threaded cap drilled to accommodate a lead-seal wire and a lock nut shall be provided on the adjusting screw to lock it in position at the desired setting. The lead seal wire shall be installed after final acceptance of the system.

2.2.1.8 Solenoids

Solenoids for operation of pilot valves shall be housed in an explosion-proof case suitable for Class I, Division 1, Group D with maximum temperature rating of ("T2D" -419 degrees F), hazardous locations as defined in \-NFPA 70-\. Solenoids shall operate on 120 volts, 60 cycle, single phase, alternating current. A manual type operator or needle valve to bypass the solenoid valve shall be provided for emergency manual operation.

2.2.2 Serviceability of Main Valve Internal Parts

Main valve movable parts including strainers, valve seat, stem bearings, and control system shall be replaceable without removing the main valve from the line. All nonmetallic parts shall be replaceable.

2.2.3 Total Lengths

The total valve length does not include the orifice plate flange (when used). If the control valve being supplied has the orifice plate built into its flange, the spacer provided shall bring the valve face-to-face dimension equal to those listed below plus 0.0875 of an inch. The lengths of the valves shall be equal for the following materials: cast stainless steel, cast steel and cast aluminum.

SIZE	VALVE LENGTH

INCHES	(INCHES)
1-1/2	8.5
2	9.375
3	12
4	15
6	20
8	25.4
10	29.8
12	34
14	39
16	41.375

Tolerance shall be ±0.030 of an inch for size one and one-half inches (1-1/2") through eight inches (8") and ±0.060 on an inch for size 10 thru 16 inches.

Control valves not meeting these face to face dimensions shall be supplied with spacers suitable for the proper installation of the valve.

2.2.4 Flanges

	MATERIAL	SEALING SURFACE
A:	Cast Steel, \-ASME B16.5-\ Class 150	Raised Face
B:	Cast Stainless Steel, \-ASME B16.5-\ Class 150	Raised Face
C:	Cast Aluminum, Suitable for minimum working pressure of 275 psig at 100 degrees F.	Flat Face

The mating flange shall be made the same as above.

2.2.5 Identification

2.2.5.1 Main Valve Body

The following shall be cast into the main valve body:

a. Pressure Class
b. Size
c. Material
d. Foundry Heat Number and Identification
e. Manufacturer
f. Flow Pattern

2.2.5.2 Main Valve Cover

The following shall be cast into the main valve cover:

a. Size
b. Material
c. Foundry Heat Number and Identification

2.2.5.3 Brass Name Plates

Brass name plates shall be fastened to the valve. Body name plates shall list the following:

a. Size
b. Model Number
c. Stock Number
d. Manufacturer/Supplier
e. Manufacturer's Inspection Stamp

2.2.5.4 Inlet Name Plate

Inlet name plate shall list the following:

a. Size
b. "Inlet" Marking
c. Assembly Model Number
d. Part Number

2.2.5.5 Outlet Name Plate

Outlet name plate shall list the "Outlet" Marking.

2.2.5.6 Pilot Valves

Pilot valves shall be tag identified.

2.3 MATERIALS

The type of materials which come in contact with the fuel, if not specified hereinbefore, shall be noncorrosive.

2.4 INDIVIDUAL CONTROL VALVE OPERATIONAL REQUIREMENTS

Operation, performance, and special features of the individual control valves shall be as specified herein.

2.4.1 Air Block/Check Valve (CV-1 THRU CV-3)

2.4.1.1 Size

Four-inch (4").

2.4.1.2 Flow

0-640 GPM.

2.4.1.3 Operation

Backpressure control pilots will cause main valve to modulate to maintain constant inlet pressure. There shall be three backpressure control pilots, A, B, and C. Pilot A shall be solenoid enabled and set at pressure which corresponds with unloading pump flow rate of 600 gpm. Pilot B shall be solenoid enabled and set at pressure which corresponds with unloading pump flow rate of 300 gpm. Pilot C is not solenoid controlled and is set at pressure corresponding with unloading pump flow rate of 150 gpm. All pilots are to have 20-200 psig range.

2.4.1.4 Speed Control

Valve shall open slowly. Opening speed shall be adjustable from two (2) to 30 seconds without affecting closing of valve. Factory set for 15 seconds. The valves shall fail closed against reverse flow in check condition.

2.4.1.5 Check Valve Feature

Valve closure to be rapid, closing quickly when outlet pressure exceeds inlet pressure.

2.4.1.6 Solenoid Control

Solenoid control valves shall be as indicated on the drawings.

2.4.1.7 Strainer

A 40-mesh, stainless steel wire, self-cleaning strainer shall be provided in the pilot valve supply piping.

PART 3 EXECUTION

3.1 VALVE TESTING AND START-UP SUPPORT

The Contractor shall provide the services of a factory trained and certified service engineer employed by the valve manufacturer to verify that each valve has been properly installed and to verify valves were factory operationally tested, adjusted and set per these specifications. The service engineer shall assist the Contractor in the valve start-up adjustment process and will remain on site until all control valves function as required by the contract documents.

3.1.1 Standard 1-Year Warranty Period

If a problem attributable to the valve's manufacturer or installation arises after the initial system start-up has been accomplished, and after system final acceptance date, the Contractor shall have 48 hours from the time of notification that a problem exists to solve the problem. The problem shall be solved to the satisfaction of the Contracting Officer, the Base Civil Engineer and/or the Command Fuel Facilities Engineer . If the Contractor cannot effectuate a proper resolution to the problem as outlined above in the 48 hour period, the Contractor shall provide a factory trained engineer from the manufacturer of the valve within 48 hours after the expiration of the Contractor's initial 48 hour period to effectuate a resolution of the problem above. All services provided by the valve manufacturer shall be at no cost to the Government. When it has been determined by the Contractor, Contracting Officer, and the valve manufacturer's representative that the valve(s) cannot be repaired in its installed position in the fuel system, it shall be replaced with a new valve and pilot assembly within 48 hours after the initial 96-hour period listed above expires and at no cost to the Government.

3.2 TRAINING

The manufacturer shall conduct one four- (4-)hour training classes for Liquid Fuels Maintenance Technicians which include valve overhaul procedures, pilot overhaul procedures, valve adjustments, and valve diagnostics. The

manufacturer shall provide a four-inch (4") valve mock-up with various trim components (i.e., rate of flow, solenoid control, and speed control features) to be used during training. The four-inch (4") valve mock-up shall become the property of the Government and shall be turned over to the Contracting Officer.

SECTION 15140

PUMPS, FUELING SYSTEM

SECTION 15140

PUMPS, FUELING SYSTEM

PART 1 GENERAL

1.1 REFERENCES.

The publication listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only:

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)

\-AFBMA 7-\	(1988) Shaft and Housing Fits for Metric Radial Ball and Roller Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

\-ASME B16.5-\	(1988; Errata-Oct 1988) Pipe Flanges and Flanged Fittings

AMERICAN PETROLEUM INSTITUTE (API)

\-API STD 610-\	(1995) Centrifugal Pumps for General Refining Service

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A182/A182M-\	(1996e) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service
\-ASTM A276-\	(1996) Stainless Steel Bars and Shapes
\-ASTM A356/A356M-\	(1996) Heavy-Walled, Carbon Low Alloy, and Stainless Steel Castings or Steam Turbines
\-ASTM A487/A487M-\	(1993) Steel Casing for Pressure Service
\-ASTM A582/A582M-\	(1995b) Free-Machining Stainless Steel Bars
\-ASTM A743/A743M-\	(1995) Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
\-ASTM C827-\	(1987) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

HYDRAULIC INSTITUTE (HI)

\-HI-01-\	(1983; 14th Ed.) Standard for Centrifugal, Rotary, and Standard Reciprocating Pumps

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE Std 112-\ (1996) Test Procedure for Polyphase Induction Motors and Generators

MILITARY SPECIFICATIONS (MS)

\-MS MIL-P-24441-\ (1991; Rev. B, Supp. 1) Paint Epoxy - Polyamide, General Specification for

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

\-NEMA MG 1-\ (1993; Rev 1) Motors and Generators

NATIONAL FIRE PROTECTION AGENCY (NFPA).

\-NFPA 70-\ (1996) National Electrical Code

STEEL STRUCTURES PAINTING COUNCIL (SSPC).

\-SSPC PA 1-\ (1991) Paint Application Specification No. 1 Shop, Field, and Maintenance Painting

\-SSPC SP 10-\ (1991) Surface Preparation Specification No. 10 Near-White Blast Cleaning

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having and "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Offload Pump (OP-1 through OP-3)\; *GA*\; *MEEL*\

SD-04 Drawings\

Offload Pump (OP-1 through OP-3)\; *GA*\

SD-13 Certificates\

Offload Pump (OP-1 through OP-3)\; *GA*\

SD-09 Reports\

Certified Test Curves\; *FIO*\

Hydrostatic, performance, and NPSH tests shall be conducted at the factory on each pump in accord with Hydraulic Institute Standard for Centrifugal, Rotary and Reciprocating Pumps. Test each pump with the actual motor which will drive the pump in the field. Test reports shall bear the serial number of both pump and driver. Submit manufacturer's certified reports of hydrostatic, performance, and NPSH tests. Submit manufacturer's certified test curve. All tests shall be observed by the Contracting Officer or his designated representative. The Contractor shall give the Contracting Office 14 days notice prior to conductance of factory tests in order to schedule observing of factory test.

SD-19 Operation and Maintenance Manuals\

Operation and Maintenance Manuals\; *GA*\

Operation and maintenance information shall be submitted for the pumps and appurtenance specified herein.

1.2.1 Submittal Sequence

Performance testing shall not occur prior to acceptance of shop drawing submittal.

1.3 ELECTRICAL WORK

Motors, manual or automatic motor control equipment except where installed in motor control centers, and protective or signal devices required for the operation specified herein shall be provided under this section in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR. Motors shall be high efficiency type and in accordance with Section \=16415=\ ELECTRICAL WORK, INTERIOR.

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

Shall be as specified in Section \=15050=\ MECHANICAL EQUIPMENT, FUEL SYSTEM.

OFFLOAD PUMPS (OP-1 through OP-3)

2.1.1 Capacity

Capacity shall be 600 gpm against a total head of 385 feet when driven at 3600 rpm. Overall efficiency at design conditions of pump and driver, connected, shall be minimum of 60 percent. Pump head capacity shall be continually rising and shall be free of dips and valleys from design point to shut-off head. Pump shut-off head shall have a 10 percent to 20 percent head rise to shut off. Pump shall be capable of at least a 10 percent head increase at rated conditions by installing a new impeller. Pumps shall not overheat or be damaged in any way while operating continuously at a minimum flow condition of 150 gpm and continuously at a maximum flow condition of 125 percent required capacity GPM. The unit will also be required to operate at a flow of 12.5 percent required capacity GPM without exceeding the vibration limits given in \-API STD 610-\. These pumps are for parallel operation and shall have equal head at minimum continuous stable flow, plus or minus 2 percent.

2.1.2 General Requirements

The pumps for this service shall meet the requirements of \-API STD 610-\, latest edition. Whenever the information contained herein conflicts with said standard, the information here in shall govern. The pumps for this service shall run at a nominal 3600 rpm and shall be single stage centrifugals, horizontally mounted, vertical or radial split case, enclosed impeller, with end suction and top vertical discharge. Pumps shall be of the back pull-out design to permit removing case half from rear for access to internal parts

without disturbing the suction or discharge piping or the driver. All parts shall be factory inspected so that parts are interchangeable. Pumps and motors shall be furnished as complete units as herein specified. Pump assembly shall be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow.

2.1.2.1 The pump shall require no more than 11-feet of net positive suction head (NPSHR) when it is operated with water at a capacity of 600 gpm at rated head and speed. A hydrocarbon reduction or correction factor shall not be used. Pump suction specific speed shall be less than 12,000.

2.1.2.2 The pump shall be horizontal, single stage, single suction with double volute construction to assure radial balance. It shall be designed to permit removal of the impeller, shaft, bearings and bearing housing as an assembly, without disconnecting the suction or discharge piping.

2.1.2.3 The pump case shall be end suction, centerline discharge type for ease of piping alignment. Flange ratings shall be class 300-pound per \-ASME B16.5-\. The case shall be designed for maximum discharge pressure at pumping temperature but not less than 550 psig, with a minimum corrosion allowance of 1/8-inch. The suction and discharge flanges as well as the cover bolting surfaces shall be backfaced or spotfaced for positive bolt seating. The radial case to cover split shall be a metal-to-metal fit with a confined, controlled compression gasket.

2.1.2.4 The pump cover shall contain a stuffingbox designed to accept an unbalanced mechanical seal. The stuffingbox shall have a minimum of three-inch studs for seal gland bolting. The gasket fit for seal gland to stuffingbox shall be of the controlled compression type with metal-to-metal joint contact.

2.1.2.5 Both case and cover are to be fitted with renewable wear rings.

2.1.2.6 The impeller shall be of the enclosed type, dynamically and hydraulically balanced. It shall be key driven, held in place by a positive lock, threaded against rotation. The running clearance between the impeller and case-cover wear rings shall be no less than .018-inches.

2.1.2.7 Mechanical Seal. A single unbalanced mechanical seal per \-API STD 610-\ code USTFM of multiple spring design shall be supplied. The seal gland shall be taped for three connections and each shall be stamped for identification as follows: Q for quench; F for flush; and D for drain. A non-sparking throttle bushing pressed into the seal end plate against an outside shoulder shall be provided to minimize leakage on complete seal failure.

2.1.2.8 Bearing Housing. Oil lubricated anti-friction, radial and thrust bearings of standard design shall be supplied. The bearings shall be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Bearings shall be retained on the shaft and fitted into housings in accordance with \-AFBMA 7-\. Locking of the ball thrust bearing to the shaft shall be by series W tank type washer. Minimum spacing between bearing centerlines shall be 6.5-inches.

2.1.2.9 A sight glass for checking oil level with a permanent indication of proper oil level shall be supplied.

2.1.2.10 Bearing housings shall be equipped with labyrinth type end seals and deflectors where the shaft passes through the housing; lip-type seals shall not be used. Deflectors shall be made of non-sparking material. The deflector design shall effectively retain oil in the housing and prevent entry of foreign material into the housing.

2.1.2.11 Shafts shall be of ample size to transmit the maximum torque required under specified operating conditions, and to withstand continuously all stresses resulting from supported weights, thrusts and starting, including across-the-line motor starting. It shall be key seated to provide positive drive for the coupling, shaft sleeve and impeller. The shaft stiffness factor shall be under 70. The radial bearing centerline to impeller centerline, distance and the pump shaft diameter under the sleeve shall be provided to calculate the factor.

2.1.2.12 A replaceable hooked-type shaft sleeve, locked in place by the impeller shall extend under the mechanical seal and gland.

2.1.2.13 A spacer coupling shall be supplied. The spacer length shall permit the removal of the assembled pullout element without disturbing the driver or the suction and discharge piping. Couplings shall be properly keyed in place. Cylindrical fits shall be light enough to permit easy removal of the hub in the field without the need for heating. A service factor of at least 1.5 shall be used in selecting couplings based on manufacturer's ratings.

2.1.2.14 Removable coupling guards of the non-sparking type shall be supplied. They shall comply with the requirements of OSHA.

2.1.2.15 Total indicated shaft runout at coupling end shall be 0.001-inches or less. Total shaft deflection shall be no more than 0.002-inches at face of stuffingbox.

2.1.2.16 Baseplate

The baseplate shall be of fabricated steel construction. It shall be of the drain pan style, sloping from back to front. Connections for a drain shall be tapped (1-inch minimum) at the pump end and located to accomplish complete drainage. A grout hole of at least 8-inches minimum diameter shall be supplied and shall have 1/2-inch minimum raised lip edge.

2.1.2.17 Materials

No zinc, brass, bronze or other copper bearing alloy shall come in contact with the fuel.

2.1.2.18 The case and cover shall be constructed of stainless steel \-ASTM A487/A487M-\ GR CF8M or \-ASTM A487/A487M-\ GR CA6NM or aluminum \-ASTM A356/A356M-\ GR T6.

2.1.2.19 Impeller material shall be stainless steel \-ASTM A487/A487M-\ GR CF8M or \-ASTM A743/A743M-\ CA 6NM.

2.1.2.20 Wear rings shall be stainless steel \-ASTM A182/A82M-\ GR F6 or \-ASTM A276-\ TP410 or 416.

2.1.2.21 Shaft shall be stainless steel \-ASTM A276-\ type 410 or 416 or \-ASTM 258-\ Type 410 or 416 with renewable shaft sleeve of \-ASTM A276-\ type 316L with hard facing under mechanical seal gasket.

2.1.2.22 Testing

All shop testing shall be performed in accordance with the \-HI-01-\.

2.1.3 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the pump, shall be furnished in addition to the identification nameplate. The pump service nameplate shall be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, gpm
Pumping head, ft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.1.4 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel shall be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 1/4-inch high shall bear the equipment number as shown on the drawings.

2.1.5 Exterior Primer Coat

Exterior surfaces of the baseplate shall be primed by the manufacturer. Coating shall be applied meeting requirements of \-SSPC PA 1-\. Surface cleaning shall meet requirements of \-SSPC SP 10-\. Metal primer shall be zinc rich paint conforming to specification \-MS MIL-P-24441-\, Type 1, Class 3. Dry film thickness shall be 2 to 4 mils.

2.1.6 Exterior Topcoat

Manufacturer's standard exterior topcoat shall be applied at factory to the base plate.

2.1.7 Motors

2.1.7.1 Motor shall be furnished by the pump manufacturer and shall be suitable for the environment and operating conditions to which it will be subjected. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor shall be UL listed for use in Class I, Division 1, Group D hazardous areas, and shall have a maximum temperature rating of "T2D - 419 degrees F" as defined by \-NFPA 70-\. The motor nameplate shall include the temperature rating of the motor and locked-rotor indicating code letters in accordance with \-NFPA 70-\, Table 430-7(b).

2.1.7.2 Voltage rating shall be 460 volts, 3 phase, 60HZ. Motor nominal speed shall match pump. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10% above or below rated voltage.

2.1.7.3 Pump manufacturer shall assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve. In addition to having sufficient horsepower-output rating at rated speed, motor shall have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of ten (10) starts per hour. Attention is specifically directed to the fact that thermal characteristics of motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors shall conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to variation, service factors above unity shall not be applied in sizing motor.

2.1.7.4 Motor shall be squirrel-cage induction type. Motor shall be NEMA Design B (normal-torque, low starting current).

2.1.7.5 Motor insulation shall be non-hydroscopic, NEMA Class H, 180 degrees C for motors over 10 hp and NEMA Class F, 150 degrees C for 10 hp and smaller. Stator windings shall be epoxy impregnated. The impregnations shall be applied by the vacuum and pressure process.

2.1.7.6 Winding temperature rise, (based on a maximum ambient temperature of 40 degrees C at 3300-feet altitude) shall not exceed 80 degrees C.

2.1.7.7 Bearings shall be AFBMA minimum L10 life of 60,000 hours or L50 life of 300,000 hours suitable for the size, type, and application when the pump is operating at the specified flow and head.

2.1.7.8 Motor enclosures shall be totally enclosed, weather sealed, fan cooled, explosion-proof and shall be listed and labeled for Class I, Group D areas. Provide bronze ground bolt on motor enclosure. All motor external electrical connections shall be terminated within a single terminal housing.

2.1.7.9 The dynamic balance, overspeed withstand capability, and sound power levels of the motor shall conform with NEMA standard requirements.

2.1.7.10 The pump manufacturer shall furnish the Contracting Officer with the recommended minimum run time for the motor.

2.1.7.11 Pump motor shall be provided with temperature limiting thermostats within the motor frame when required to meet Class I, Group D requirements.

2.1.7.12 Pump motor shall be furnished with lifting lugs on the motor casing.

2.1.7.13 Unless indicated otherwise, motors for conventional applications over 15 horsepower shall be the energy efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors,

motors specified as part of energy efficient equipment, wound rotor motors, or any application involving special construction or performance. Guaranteed minimum full load efficiencies shall be (based on 1800 rpm, open drip proof):

20 hp	92.0%	75 hp	95.5%
25 hp	92.0%	100 hp	93.5%
30 hp	92.0%	125 hp	94.5%
40 hp	92.0%	150 hp	94.5%
50 hp	92.5%	200 hp	94.5%
60 hp	92.5%	600 hp	94.5%

Other motors of different speed or housing classification shall also be of the energy efficient type, as advertised by the motor manufacturer, with efficiency greater than the standard line. Motor efficiencies shall have been verified in accordance with \-NEMA MG 1-\, 12.53.a., and determined using the dynamometer method as described in \-IEEE Std 112-\, Method B. All shop drawing submittals on motor driven equipment shall include the motor efficiency.

PART 3 EXECUTION

3.1 PREPARATION FOR SHIPMENT

3.1.1 Rust Preventative

Exterior machine surfaces shall be coated with a rust preventative. Pumps shall be disassembled after the shop running tests and inspected, and internal parts shall be coated with a rust preventative before reassembling.

3.1.2 Closure of Openings

Threaded openings shall be provided with metallic plugs or caps. Flanges shall be gasketed with rubber and closed with 3/16-inch thick plate of the same outside diameter as the match flange. A minimum of four full-diameter bolts shall hold closure in place.

3.1.3 Assembly

Pumps shall be shipped assembled or a field service engineer shall be furnished to supervise the field assembly at no additional cost to the Government.

3.1.4 Bracing

Each unit shall be suitably prepared for shipment, supported and braced, with auxiliary equipment secured to prevent damage during shipment.

3.1.5 Vapor Inhibiting Wraps

Exposed shafts and shaft couplings shall be wrapped with waterproof moldable waxed cloth or vapor inhibitor paper. The seams shall be sealed with adhesive tape.

3.1.6 Shipping Identification

Each pump shall be identified with a metal tag showing the item number. Material shipped separately shall be marked with a metal tag indicating the item number for which it is intended.

3.2 INSTALLATION

Install equipment and components true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearances between equipment components. Equipment, apparatus, and accessories requiring normal servicing or maintenance shall be easily accessible.

3.2.1 Anchoring

Anchor equipment in place as indicated on the drawings or per manufacturer's recommendations. Check alignment of anchor bolts and/or bolt holes before installing equipment and clean-out associated sleeves. Do not cut bolts due to misalignment. Notify the Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads.

3.2.2 Grouting

Equipment which is anchored to a pad shall be grouted in place. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, coatings and other materials which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting to meet requirements of \-ASTM C827-\. Perform all grouting in accord with equipment manufacturer's and grout manufacturer's published specifications and recommendations.

3.2.3 Leveling and Aligning

Level and align equipment in accord with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.2.4 Direct Drives

Alignment procedure follows.

3.2.4.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.2.4.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.2.4.3 Shaft Leveling and Radial Alignment

Check shaft leveling by placing a straightedge across the two coupling half faces in both horizontal and vertical planes.

3.2.4.4 Angular Alignment and End Clearance

Check angular alignment and en clearance by inserting a feeler gage at 4 points, 90 degrees apart around outer edges of coupling halves.

3.2.4.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.002-inch tolerance, except as otherwise required by more stringent requirements of equipment manufacturer.

3.2.5 Start-up Representative

A manufacturer's field service representative shall be provided at no additional cost to the Government to check the pumps for proper operation prior to start-up and also to witness as a minimum the first two days of operation. Any additional time required due to delays or corrections by the Contractor shall be provided at no additional cost to the Government. The manufacturer's field service representative shall also instruct the required personnel in the proper operation and maintenance of the pumps.

SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI C80.1-\	(1990) Rigid Steel Conduit - Zinc Coated
\-ANSI C119.1-\	(1986) Sealed Insulated Underground Connector Systems Rated 600 Volts

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 123-\	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
\-ASTM A 153-\	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
\-ASTM B 8-\	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
\-ASTM B 117-\	(1994) Operating Salt Spray (Fog) Testing Apparatus
\-ASTM D 1654-\	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE C2-\	(1997) National Electrical Safety Code
\-IEEE Std 81-\	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
\-IEEE Std 100-\	(1992) IEEE Standard Dictionary of Electrical and Electronics Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

\-NEMA FB 1-\	(1993) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
\-NEMA TC 5-\	(1990) Corrugated Polyolefin Coilable Plastic Utilities Duct

\-NEMA TC 6-\	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation
\-NEMA TC 7-\	(1990) Smooth-Wall Coilable Polyethylene Electrical Plastic Duct
\-NEMA WC 7-\	(1993) Cross-Linked-Thermosetting-Polyethylene- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
\-NEMA WC 8-\	(1993) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 70-\	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

\-UL 6-\	(1993; Rev March 96) Rigid Metal Conduit
\-UL 467-\	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
\-UL 486A-\	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors
\-UL 514A-\	(1996) Metallic Outlet Boxes
\-UL 651-\	(1995) Schedule 40 and 80 Rigid PVC Conduit
\-UL 1242-\	(1996) Intermediate Metal Conduit

1..2. GENERAL REQUIREMENTS

1..2..1. Terminology

Terminology used in this specification is as defined in \-IEEE Std 100-\.

1..3. SUBMITTALS

Governmental approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Manufacturer's Catalog Data\; *GA*\.

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists\; *GA*\.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

Installation Procedures\; *GA*\.

As a minimum, installation procedures for transformers, and medium-voltage cable terminations and splices.

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-04 Drawings\

Electrical Distribution System\; *GA*\.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following: Motor installations

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

As-Built Drawings\; *FIO*\.

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and

other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

SD-09 Reports\

Factory Test\; *GA*\.

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing\; *GA*\.

A proposed field test plan, 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Test Reports\; *GA*\.

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

SD-13 Certificates\

Materials and Equipment\; *GA*\.

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute

(ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

SD-19 OPERATION AND MAINTENANCE MANUALS\

Electrical Distribution System\; *GA*\.

Six copies of operation and maintenance manuals, within 7 calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

1..4. DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced.

1..5. EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

PART 2. PRODUCTS

2..1. STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2..2. NAMEPLATES

2..2..1. General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal.

2..2..2. NOT USED

2..3. CORROSION PROTECTION

2..3..1. Aluminum Materials

Aluminum shall not be used.

2..3..2. Ferrous Metal Materials

2..3..2..1. Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with \-ASTM A 153-\ and \-ASTM A 123-\.

2..3..2..2. Equipment

Equipment and component items, including but not limited to ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in \-ASTM B 117-\ without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be in accordance with \-ASTM D 1654-\ with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2..3..3. Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section \=09900=\ PAINTING, GENERAL.

2..4. CABLES

Cables shall be single conductor type unless otherwise indicated.

2..4..1. Conductor Material

Underground cables shall be of soft drawn copper conductor material.

2..4..2. NOT USED

2..4..3. Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of \-NFPA 70-\. Cables shall utilize cross-linked thermosetting polyethylene (XLP) insulation and shall conform to the requirements of \-NEMA WC 7-\ or ethylene-propylene-rubber (EPR) insulation and shall conform to the requirements of \-NEMA WC 8-\ .

2..4..3..1. NOT USED

2..4..3..2. In Duct

Cables shall be single-conductor cable, Type RHW, THW, THWN, TW, USE, or XHHW in accordance with \-NFPA 70-\. Cables in factory-installed, coilable-plastic-duct assemblies shall conform to \-NEMA TC 5-\ or \-NEMA TC 7-\.

2..5. CABLE JOINTS, TERMINATIONS, AND CONNECTORS

2..5..1. NOT USED

2..5..2. NOT USED

2..5..3. Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of \-UL 486A-\. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of \-UL 486A-\. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to \-ANSI C119.1-\ or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

2..6. CONDUIT AND DUCTS

Duct lines shall be nonencased direct-burial, thick-wall type.

2..6..1. Metallic Conduit

Intermediate metal conduit shall comply with \-UL 1242-\. Rigid galvanized steel conduit shall comply with \-UL 6-\ and \-ANSI C80.1-\. Metallic conduit fittings and outlets shall comply with \-UL 514A-\ and \-NEMA FB 1-\.

2..6..2. Nonmetallic Ducts

2..6..2..1. NOT USED

2..6..2..2. NOT USED

2..6..2..3. Direct Burial

\-UL 651-\ Schedule 80 , or \-NEMA TC 6-\ Type DB.

2..6..3. Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

2..7. HANDHOLES

Handholes shall be as indicated. Strength of handholes and their frames and covers shall conform to the requirements of \-IEEE C2-\. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 10,000 psi and a flexural strength of at least 5,000 psi. Handhole covers in sidewalks, and turfed areas shall be of the same material as the box.

2..8. NOT USED

2..9. NOT USED

2..10. NOT USED

2..11. NOT USED

2..12. GROUNDING AND BONDING

2..12..1. Driven Ground Rods

Ground rods shall be copper-clad steel conforming to \-UL 467-\ not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used.

2..12..2. Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be \-ASTM B 8-\ soft-drawn unless otherwise indicated. Aluminum is not acceptable.

2..13. CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section \=03300=\ CAST-IN-PLACE STRUCTURAL CONCRETE.

PART 3. EXECUTION

3..1. GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section \=16415=\ ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section \=02222=\ EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section \=03300=\ CAST-IN-PLACE STRUCTURAL CONCRETE.

3..1..1. Conformance to Codes

The installation shall comply with the requirements and recommendations of \-NFPA 70-\ and \-IEEE C2-\ as applicable.

3..1..2. Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

3..2. CABLE INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then prepare a checklist of significant requirements which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

3..2..1. Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

3..2..1..1. Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

3..2..1..2. Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 1/4 inch less than inside diameter of duct, 2 wire

brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 8 cubic inches of debris is expelled from the duct.

3..2..1..3. Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

3..2..1..4. Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 50 degrees F temperature for at least 24 hours before installation.

3..2..1..5. Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall thrust pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

3..2..2. Duct Line

Cables shall be installed in duct lines where indicated. Cable splices in low-voltage cables shall be made in handholes only, except as otherwise noted. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

3..3. NOT USED

3..4. NOT USED

3..5. DUCT LINES

3..5..1. Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a handhole, or between handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

3..5..2. Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3..5..3. NOT USED

3..5..4. Nonencased Direct-Burial

Top of duct lines shall be below the frost line depth of 30 inches, but not less than 30 inches below finished grade and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Bottoms of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 6 inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 3 to 6 inch layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

3..5..5. Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

3..5..5..1. NOT USED

3..5..5..2. Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

3..5..6. Duct Line Markers

Duct line markers shall be provided at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

3..6. HANDHOLES

3..6..1. NOT USED

3..6..2. NOT USED

3..6..3. NOT USED

3..6..4. Handholes

Handholes shall be located approximately as shown. Handholes shall be of the type noted on the drawings and shall be constructed in accordance with the details shown.

3..6..5. NOT USED

3..6..6. Ground Rods

A ground rod shall be installed at the handholes.

3..7. NOT USED

3..8. NOT USED

3..9. CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated, and shall be connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 5 feet outside of a building and 2.5 feet below finished

grade as specified and provided under Section \=16415=\ ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed with caulking compound to prevent entrance of moisture or gases into buildings.

3..10. GROUNDING

Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. Metallic frames and covers of handholes shall be grounded by use of a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

3..10..1. Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade.

3..10..2. Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with \-UL 467-\, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

3..10..3. Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

3..10..4. NOT USED

3..10..5. Handhole Grounding

Ground rods installed in handholes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to handhole walls and the amount of exposed bare wire shall be held to a minimum.

3..11. FIELD TESTING

3..11..1. General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 20 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

3..11..2. Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3..11..3. \+Ground-Resistance Tests+

The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in \-IEEE Std 81-\. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - 25 ohms.

3..11..4. **NOT USED**

3..11..5. NOT USED

3..11..6. \+Low-Voltage Cable Test+

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

3..11..7. NOT USED

3..11..8. NOT USED

3..11..9. NOT USED

3..11..10. NOT USED

3..11..11. NOT USED

3..11..12. NOT USED

3..11..13. \+Operating Tests+

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

3..12. MANUFACTURER'S FIELD SERVICE

3..12..1. Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations.

3..12..2. Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3..13. ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

SECTION 16415

ELECTRICAL WORK, INTERIOR

SECTION 16415

ELECTRICAL WORK, INTERIOR

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI C80.5-\	(1990) Rigid Aluminum Conduit

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM B 1-\	(1990) Hard-Drawn Copper Wire
\-ASTM B 8-\	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
\-ASTM D 709-\	(1992) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE Std 81-\	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
\-IEEE Std 242-\	(1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
\-IEEE Std 399-\	(1990) Recommended Practice for Power Systems Analysis

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

\-NEMA 250-\	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
\-NEMA AB 1-\	(1993) Molded Case Circuit Breakers and Molded Case Switches
\-NEMA FU 1-\	(1986) Low Voltage Cartridge Fuses
\-NEMA ICS 1-\	(1993) Industrial Controls and Systems
\-NEMA ICS 2-\	(1993) Industrial Control and Systems, Controllers, Contactors Overload Relays Rated not More Than 2,000 Volts AC or 750 DC
\-NEMA ICS 3-\	(1993) Industrial Systems

\-NEMA ICS 6-\	(1993) Industrial Control and Systems, Enclosures
\-NEMA MG 1-\	(1993; Rev 1) Motors and Generators
\-NEMA MG 10-\	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
\-NEMA OS 1-\	(1989) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
\-NEMA RN 1-\	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
\-NEMA WD 1-\	(1983; R 1989) General Requirements for Wiring Devices
\-NEMA WD 6-\	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 70-\	(1996) National Electrical Code
\-NFPA 101-\	(1994) Safety to Life from Fire in Buildings and Structures

UNDERWRITERS LABORATORIES (UL)

\-UL-03-\	(1996) Electrical Construction Materials Directory
\-UL 1-\	(1993; Rev thru Jan 1995) Flexible Metal Conduit
\-UL 6-\	(1993; Rev March 96) Rigid Metal Conduit
\-UL 20-\	(1995) General-Use Snap Switches
\-UL 44-\	(1991; Rev thru Jun 1996) Rubber-Insulated Wires and Cables
\-UL 50-\	(1995) Enclosures for Electrical Equipment
\-UL 83-\	(1991; Rev thru Jun 1996) Thermoplastic-Insulated Wires and Cables
\-UL 98-\	(1994; R Oct 1995) Enclosed and Dead-Front Switches
\-UL 198B-\	(1995) Class H Fuses
\-UL 198C-\	(1986; Rev thru Jun 1993) High-Interrupting-Capacity Fuses, Current-Limiting Types

\-UL 198D-\	(1995) Class K Fuses
\-UL 198E-\	(1988; Rev Jul 1988) Class R Fuses
\-UL 198G-\	(1988; Rev May 1988) Fuses for Supplementary Overcurrent Protection
\-UL 198H-\	(1988; Rev thru Nov 1993) Class T Fuses
\-UL 198L-\	(1995; Rev May 1995) D-C Fuses for Industrial Use
\-UL 360-\	(1986; Rev thru Dec 1995) Liquid-Tight Flexible Steel Conduit
\-UL 467-\	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
\-UL 486A-\	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors
\-UL 486C-\	(1991; Rev thru Oct 1996) Splicing Wire Connectors
\-UL 486E-\	(1994; Rev Aug 95) Equipment Wiring Terminal for Use with Aluminum and/or Copper Conductors
\-UL 489-\	(1996) Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
\-UL 508-\	(1993) Industrial Control Equipment
\-UL 510-\	(1994) Insulating Tape
\-UL 512-\	(1993; R Dec 1995) Fuseholders
\-UL 514B-\	(1989; Rev thru Apr 1995) Fittings for Conduit and Outlet Boxes
\-UL 514C-\	(1988; Rev thru Jul 1996) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
\-UL 674-\	(1994; Rev thru Jul 1996) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
\-UL 698-\	(1995; Rev thru Jul 1996) Industrial Control Equipment for Use in Hazardous (Classified) Locations
\-UL 797-\	(1993; Rev May 1995) Electrical Metallic Tubing
\-UL 817-\	(1994; Rev thru May 1996) Cord Sets and Power-Supply Cords
\-UL 845-\	(1995; Rev Feb 1996) Motor Control Centers

\-UL 886-\	(1994; Rev thru Jul 1995) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
\-UL 1004-\	(1994; Rev thru May 1996) Electric Motors
\-UL 1242-\	(1983; Rev thru Jul 1993) Intermediate Metal Conduit
\-UL 1660-\	(1994) Liquid-Tight Flexible Nonmetallic Conduit

1..2. GENERAL

1..2..1. Rules

The installation shall conform to the requirements of \-NFPA 70-\ and \-NFPA 101-\, unless more stringent requirements are indicated herein or shown. All electrical work on Pope AFB shall be performed by personnel authorized to engage in electrical contracting within the state of North Carolina and shall hold a North Carolina electrical license. An electrical license from another state may be acceptable if it qualifies under North Carolina's reciprocity process. A submittal of a certified copy of the electrical license shall be required.

1..2..2. Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Raceways, junction and outlet boxes shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate electrical work with the HVAC and electrical drawings and specifications and provide power related wiring.

1..2..3. Special Environments

1..2..3..1. Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to \-NFPA 70-\ requirements for installation in damp or wet locations.

1..2..3..2. Hazardous Locations

Wiring and equipment in locations indicated shall be of the classes, groups, divisions, and suitable for the operating temperature; as indicated.

1..2..4. Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1..2..5. NAMEPLATES

1..2..5..1. Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with \-ASTM D 709-\ with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates: Motors and Motor Contol Center

Minimum 1/4 inch High Letters	Minimum 1/8 inch High Letters
Motors	Control Power Transformers
Starters	Control Devices
Safety Switches	Instrument Transformers
Motor Control Centers	
Equipment Enclosures	

Each panel, section, or unit in motor control centers, switchgear or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

1..2..6. As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish two sets of as-built drawings to the Contracting Officer.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01330=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Fault Current and Protective Device Coordination Study\; *GA*\.

The study shall be submitted along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study, The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog\; *GA*\.

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists\; *GA*\.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures\; *GA*\.

Installation procedures for rotating equipment and new motor starters in existing motor control center. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

SD-04 Drawings\

Interior Electrical Equipment\; *GA*\.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

a. Motor control centers.

As-Built Drawings\; *FIO*\.

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily.

The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

SD-08 Statements\

On-Site Test\; *GA*\.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-09 Reports\

Factory Test Reports\; *GA*\.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The conditions specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

Field Test Plan\; *GA*\.

A detailed description of the Contractor's proposed procedures for on-site test submitted 30 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports\; *GA*\.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and

replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The conditions specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

h. Final position of controls and device settings.

SD-13 Certificates\

Electrical License\; *GA*\.

Certified copy of the electrical contractors license.

Materials and Equipment\; *GA*\.

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1..4. WORKMANSHIP

Materials and equipment shall be installed in accordance with \-NFPA 70-\, recommendations of the manufacturer, and as shown.

PART 2. PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as

specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2..1. NOT USED

2..2. CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2..2..1. Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

2..2..2. NOT USED

2..2..3. Insulation

Unless indicated otherwise, or required by \-NFPA 70-\, power and lighting wires shall be 600-volt, Type THWN, THHN, or THW conforming to \-UL 83-\ or RHW conforming to \-UL 44-\, except that grounding wire may be type TW conforming to \-UL 83-\; remote-control and signal circuits shall be Type TW, THW or TF, conforming to \-UL 83-\.

2..2..4. Bonding Conductors

\-ASTM B 1-\, solid bare copper wire for sizes No. 8 AWG and smaller diameter; \-ASTM B 8-\, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2..2..5. NOT USED

2..2..6. NOT USED

2..2..7. NOT USED

2..2..8. NOT USED

2..2..9. NOT USED

2..2..10. NOT USED

2..2..11. Tray Cable or Power Limited Tray Cable

UL listed; Type TC or PLTC.

2..2..12. Cord Sets and Power-Supply Cords

\-UL 817-\.

2..3. NOT USED
2..4. NOT USED

2..5. NOT USED

2..6. CIRCUIT BREAKERS

2..6..1. MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to \-NEMA AB 1-\ and \-UL 489-\. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers.

2..6..1..1. Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper conductors only in accordance with \-UL 486E-\. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2..6..1..2. Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with \-NEMA AB 1-\. Ratings shall be coordinated with system X/R ratio.

2..6..1..3. NOT USED

2..6..1..4. Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 150 amperes.

2..7. MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors shall conform to \-UL 508-\ and shall be provided as shown. Protectors shall be used only as part of a combination

motor controller which provides coordinated motor branch-circuit overload and short-circuit protection, and shall be rated in accordance with the requirements of \-NFPA 70-\.

2..7..1. Construction

Motor short-circuit protector bodies shall be constructed of high temperature, dimensionally stable, long life, nonhygroscopic materials. Protectors shall fit special MSCP mounting clips and shall not be interchangeable with any commercially available fuses. Protectors shall have 100 percent one-way interchangeability within the A-Y letter designations. All ratings shall be clearly visible.

2..7..2. Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Letter designations shall be A through Y for motor controller Sizes 0, 1, 2, 3, 4, and 5, with 100,000 amperes interrupting capacity rating. Letter designations shall correspond to controller sizes as follows:

CONTROLLER SIZE	MSCP DESIGNATION
NEMA O	A-N
NEMA 1	A-P
NEMA 2	A-S
NEMA 3	A-U
NEMA 4	A-W
NEMA 5	A-Y

2..8. CONDUIT AND TUBING

2..8..1. Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

\-UL 797-\

2..8..2. NOT USED

2..8..3. NOT USED

2..8..4. Flexible Conduit, Steel and Plastic

General-purpose type, \-UL 1-\; liquid tight, \-UL 360-\, and \-UL 1660-\.

2..8..5. Intermediate Metal Conduit

\-UL 1242-\.

2..8..6. PVC Coated Rigid Steel Conduit

\-NEMA RN 1-\.

2..8..7. Rigid Aluminum Conduit

\-ANSI C80.5-\ and \-UL 6-\.

2..8..8. Rigid Metal Conduit

\-UL 6-\.

2..9. CONDUIT AND DEVICE BOXES AND FITTINGS

2..9..1. Boxes, Metallic Outlet

\-NEMA OS 1-\ and \-UL 514C-\.

2..9..2. NOT USED

2..9..3. Boxes, Outlet for Use in Hazardous (Classified) Locations

\-UL 886-\.

2..9..4. Boxes, Switch (Enclosed), Surface-Mounted

\-UL 98-\.

2..9..5. Fittings for Conduit and Outlet Boxes

\-UL 514B-\.

2..9..6. Fittings For Use in Hazardous (Classified) Locations

\-UL 886-\.

2..10. CONDUIT COATINGS PLASTIC RESIN SYSTEM

\-NEMA RN 1-\, Type A-40.

2..11. CONNECTORS, WIRE PRESSURE

2..11..1. For Use With Copper Conductors

\-UL 486A-\.

2..12. ELECTRICAL GROUNDING AND BONDING EQUIPMENT

\-UL 467-\.

2..12..1. Ground Rods

Ground rods shall be of copper-clad steel conforming to \-UL 467-\ not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

2..13. ENCLOSURES

\-NEMA ICS 6-\ or \-NEMA 250-\ or \-UL 698-\ for use in hazardous (classified) locations, unless otherwise specified.

2..13..1. Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with \-UL 50-\, hot-dip, zinc-coated, if sheet steel.

2..14. NOT USED

2..15. LOW-VOLTAGE FUSES AND FUSEHOLDERS

2..15..1. Fuses, Low Voltage Cartridge Type

\-NEMA FU 1-\.

2..15..2. Fuses, High-Interrupting-Capacity, Current-Limiting Type

Fuses, Class G, J, L and CC shall be in accordance with \-UL 198C-\.

2..15..3. Fuses, Class K, High-Interrupting-Capacity Type

\-UL 198D-\.

2..15..4. Fuses, Class H

\-UL 198B-\.

2..15..5. Fuses, Class R

\-UL 198E-\.

2..15..6. Fuses, Class T

\-UL 198H-\.

2..15..7. Fuses for Supplementary Overcurrent Protection

\-UL 198G-\.

2..15..8. Fuses, D-C for Industrial Use

\-UL 198L-\.

2..15..9. Fuseholders

\-UL 512-\.

2..16. NOT USED

2..17. MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to \-NEMA MG 1-\ and \-UL 1004-\ for motors; \-NEMA MG 10-\ for energy management selection of polyphase motors; and \-UL 674-\ for use of motors in hazardous (classified) locations.

2..17..1. Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

2..17..2. Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Motor Efficiencies

HP	Std. Efficiency	High Efficiency
1	77.0	85.5
1.5	78.5	85.5
2	78.5	85.5
3	78.5	88.5
5	82.5	88.5
7.5	84.0	90.0
10	85.5	90.0
15	85.5	91.0
20	87.5	92.0
25	88.5	92.0
30	88.5	92.0
40	88.5	92.0
50	89.0	92.5
60	89.0	92.5
75	89.0	95.5
100	90.0	93.5
125	91.0	94.5
150	91.0	94.5
200	91.0	94.5
250	91.0	94.5
300	91.0	94.5
350	91.0	94.5
400	91.0	94.5
500	91.0	94.5

2..18. MOTOR CONTROLS AND MOTOR CONTROL CENTERS

2..18..1. General

\-NEMA ICS 1-\, \-NEMA ICS 2-\, \-NEMA ICS 3-\ and \-NEMA ICS 6-\, and \-UL 508-\ and \-UL 845-\. New starters shall be installed in an existing motor control center.

2..18..2. Motor Starters

Combination starters shall be provided with circuit breakers, as indicated.

2..18..2..1. Reduced-Voltage Starters

Reduced-voltage starters shall be provided for polyphase motors 75 hp or larger. Reduced-voltage starters shall be of the solid state type having an adjustable time interval between application of reduced and full voltages to the motors.

2..18..3. Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2..18..4. Low-Voltage Motor Overload Relays

2..18..4..1. General

Thermal and magnetic current overload relays shall conform to \-NEMA ICS 2-\ and \-UL 508-\. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of \-NFPA 70-\. Standard units shall be used for motor starting times up to 7 seconds. Slow units shall be used for motor starting times from 8 to 12 seconds.

2..18..4..2. Construction

Manual reset type thermal relay shall be bimetallic construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

2..18..4..3. Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

2..18..5. Automatic Control Devices

2..18..5..1. Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

2..18..5..2. Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2..18..5..3. Manual/Automatic Selection

a. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. The selector switches for the truck off-load pumps shall be the keyed type and shall be keyed alike with a selector switch mounted near the pump motor. See contract drawings.

b. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

2..18..6. Motor Control Center

The control center is existing and conforms to the requirements of \-NEMA ICS 1-\, \-NEMA ICS 2-\, \-NEMA ICS 3-\ and \-NEMA ICS 6-\, and \-UL 508-\ and \-UL 845-\. Control center is the indoor type and shall contain combination starters and other equipment as indicated. Control center shall be \-NEMA ICS 2-\, Class 1, Type B.

2..19. NOT USED

2..20. NOT USED

2..21. NOT USED

2..22. SPLICE, CONDUCTOR

\-UL 486C-\.

2..23. NOT USED

2..24. SNAP SWITCHES

\-UL 20-\.

2..25. TAPES

2..25..1. Plastic Tape

\-UL 510-\.

2..25..2. Rubber Tape

\-UL 510-\.

2..26. NOT USED

2..27. NOT USED

2..28. NOT USED

2..29. NOT USED

2..30. NOT USED

2..31. WIRING DEVICES

\-NEMA WD 1-\ for wiring devices, and \-NEMA WD 6-\ for dimensional requirements of wiring devices.

2..32. NOT USED

2..33. COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment and system constructed meet the specified requirements for equipment ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. The Contractor shall provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2..33..1. Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the nearest upstream device in the existing source system and extend through the downstream devices at the load end.

2..33..2. Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. The Contractor shall coordinate with the commercial power company for fault current availability at the site.

2..33..3. Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point

shall have a unique identifier. If a fault-impedance diagram is provide, impedance data shall be shown. Locations of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

2..33..4. Fault Current Analysis

2..33..4..1. Method

The fault current analysis shall be performed in accordance with methods described in \-IEEE Std 242-\, and \-IEEE Std 399-\.

2..33..4..2. Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedances shall be those proposed. Data shall be documented in the report.

2..33..4..3. Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

2..33..5. Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. Provide a written narrative that describes: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situation where system coordination is not achievable due to device limitations (an analysis of any device curves which order overlap); coordination between upstrean and downstrean devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost changes (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2..33..6. Study Report

a. The report shall include a narrative: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

c. The report shall document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves,

current transformer ratios, and relay device curves and protective device ratings and settings.

d. The report shall contain fully coordinated composite time-current characteristic curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.

e. The report shall provide the calculations performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

PART 3. EXECUTION

3..1. GROUNDING

Grounding shall be in conformance with \-NFPA 70-\, the contract drawings, and the following specifications.

3..1..1. Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in \-IEEE Std 81-\. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, 3 additional rods not less than 6 feet on centers, or if sectional type rods are used, 2 additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use \-UL 467-\ approved connectors.

3..1..2. NOT USED

3..1..3. Grounding Conductors

A green equipment grounding conductor, sized in accordance with \-NFPA 70-\ shall be provided, regardless of the type of conduit. The equipment grounding conductor shall be carried back to the service entrance grounding connection or separately derived grounding connection. All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per \-NFPA 70-\. When boxes for receptacles, switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

3..2. WIRING METHODS

Wiring shall conform to \-NFPA 70-\, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated

conductors installed in rigid zinc-coated steel conduit electrical metallic tubing intermediate metal conduit . Wire fill in conduits shall be based on \-NFPA 70-\ for the type of conduit and wire insulations specified. Wire fill in conduits located in Class I or II hazardous areas shall be limited to 25 percent of the cross sectional area of the conduit.

3..2..1. Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 1/2 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to \-NFPA 70-\. Electrical metallic tubing (EMT) may be installed only within buildings. EMT may be installed in concrete and grout in dry locations. EMT installed in concrete or grout shall be provided with concrete tight fittings. EMT shall not be installed in damp or wet locations, or the air space of exterior masonry cavity walls. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by \-NFPA 70-\. Only UL listed adapters shall be used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by \-NFPA 70-\. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding.

3..2..1..1. Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile strength. Not less than \~254 mm^\ \~10 inches~\ of slack shall be left at each end of the pull wire.

3..2..1..2. Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

3..2..1..3. Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape

applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

3..2..1..4. NOT USED

3..2..1..5. Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

3..2..1..6. Supports

Except where otherwise permitted by \-NFPA 70-\, conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means will not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by \-NFPA 70-\, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by \-NFPA 70-\, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

3..2..1..7. Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with \-NFPA 70-\ definitions.

3..2..2. NOT USED

3..2..3. NOT USED

3..2..4. Cables and Conductors

Installation shall conform to the requirements of \-NFPA 70-\. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

3..2..4..1. Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

3..2..4..2. Use of Aluminum Conductors in Lieu of Copper. Aluminum conductors shall not be used.

3..2..4..3. NOT USED

3..2..4..4. NOT USED

3..2..4..5. Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.

3..2..4..6. Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for three-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).
277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).
120/240-volt, 1-phase: Black and red.

b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.

c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3..3. BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by \-NFPA 70-\ for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by \-NFPA 70-\. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 24 inches. The total combined area of all box openings in fire rated walls shall not exceed 100 square inches per 100 square feet. Maximum box areas for individual boxes in fire rated walls vary with the manufacturer and must not exceed the maximum specified for that box in \-UL-03-\. Only boxes listed in \-UL-03-\ shall be used in fire rated walls.

3..3..1. Box Applications

Each box shall have not less than the volume required by \-NFPA 70-\ for number of conductors enclosed in box. Boxes for metallic raceways, 4 by 4 inch nominal size and smaller, shall be of the cast-metal hub type when located in normally wet locations, when flush and surface mounted on outside of exterior surfaces, or when located in hazardous areas. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA 1 or as shown. Boxes in other locations shall be sheet steel. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

3..3..2. Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may

be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

3..3..3. Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

3..3..4. Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

3..4. NOT USED

3..5. NOT USED

3..6. NOT USED

3..7. NOT USED

3..8. NOT USED

3..9. FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be

installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination. Time-delay and non-time-delay options shall be as specified.

3..9..1. Cartridge Fuses; Noncurrent-Limiting Type

Cartridge fuses of the noncurrent-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds.

3..9..2. Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class RK1 RK5 shall have tested interrupting capacity not less than 100,000 amperes. Fuse holders shall be the type that will reject all Class H fuses.

3..9..3. NOT USED

3..9..4. NOT USED

3..9..5. Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

3..10. UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 5 feet beyond the building wall and 2 feet below finished grade, for interface with the exterior service lateral conduits . Outside conduit ends shall be bushed when used for direct burial service lateral conductors. Outside conduit ends shall be capped or plugged until connected to exterior conduit systems. Underground service lateral conductors will be extended to building service entrance and terminated in accordance with the requirements of Section \=16375=\ ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and \-NFPA 70-\.

3..11. NOT USED

3..12. MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual horsepower ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under

other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

3..13. MOTOR CONTROL

Each motor or group of motors requiring a single control and not controlled from a motor-control center shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3..13..1. Reduced-Voltage Controllers

Reduced-voltage controllers shall be provided for polyphase motors 75 hp or larger. Reduced-voltage starters shall be of the solid state type.

3..13..2. Motor Control Center

Control center is existing and shall contain combination starters and other equipment as indicated. Control centers shall be \-NEMA ICS 2-\, Class 1, Type B. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Combination starters shall be provided with circuit breakers.

3..13..3. Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with \-NEMA ICS 2-\ for rating designation B300.

3..14. MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by \-NFPA 70-\ even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3..15. NOT USED

3..16. NOT USED

3..17. NOT USED

3..18. EQUIPMENT CONNECTIONS

All wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

3..18..1. Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with \-NFPA 70-\, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

3..19. CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

3..20. PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section \=09900=\ PAINTING, GENERAL.

3..21. REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be

carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3..22. \+FIELD TESTING+

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 20 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3..22..1. Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3..22..2. \+Ground-Resistance Tests+

The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in \-IEEE Std 81-\. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - 25 ohms .

3..22..3. Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 48 hours before the site is ready for inspection.

3..22..4. \+Cable Tests+

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3..22..4..1. NOT USED

3..22..4..2. Low Voltage Cable Tests

a. Continuity test.

b. Insulation resistance test.

3..22..5. NOT USED

3..22..6. \+Motor Tests+

a. Phase rotation test to ensure proper directions.

b. Operation and sequence of reduced voltage starters.

c. High potential test on each winding to ground.

d. Insulation resistance of each winding to ground.

e. Vibration test.

f. Dielectric absorption test on motor and starter.

3..22..7. NOT USED

3..22..8. NOT USED

3..22..9. \+Circuit Breaker Tests+

The following field tests shall be performed on circuit breakers.

3..22..9..1. NOT USED

3..22..9..2. NOT USED

3..22..9..3. Circuit Breakers, Molded Case

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Closed breaker contact resistance test.

d. Manual operation of the breaker.

3..22..10. Motor Control Centers

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Manual and electrical operational tests.

3..23. \+OPERATING TESTS+

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

3..24. FIELD SERVICE

3..24..1. Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format video tape of the entire training shall be submitted.

3..24..2. Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3..25. ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

SECTION 16528

EXTERIOR LIGHTING

SECTION 16528

EXTERIOR LIGHTING

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

\-AASHTO LTS-2-\	(1985; Rev 1986, 1987, 1988) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI C2-\	(1993) National Electrical Safety Code
\-ANSI C80.1-\	(1990) Rigid Steel Conduit - Zinc Coated
\-ANSI C82.4-\	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
\-ANSI C119.1-\	(1986) Sealed Insulated Underground Connector Systems Rated 600 Volts
\-ANSI C136.2-\	(1985) Luminaires Voltage Classification
\-ANSI C136.3-\	(1989) Luminaire Attachments - for Roadway Lighting Equipment
\-ANSI C136.6-\	(1990) Roadway Lighting Equipment - Metal Heads and Reflector Assemblies - Mechanical and Optical Interchangeability
\-ANSI C136.9-\	(1990) Roadway Lighting Equipment - Socket Support Assemblies for Metal Heads - Mechanical Interchangeability
\-ANSI C136.11-\	(1988) Multiple Sockets for Roadway Lighting Equipment
\-ANSI C136.15-\	(1986) High-Intensity-Discharge and Low-Pressure Sodium Lamps in Luminaires - Field Identification

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 36-\	(1994a) Carbon Structural Steel

\-ASTM A 123-\ (1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

\-ASTM B 2-\ (1988) Medium-Hard-Drawn Copper Wire

\-ASTM B 8-\ (1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

\-ASTM B 117-\ (1994) Operating Salt Spray (Fog) Testing Apparatus

\-ASTM D 1654-\ (1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

\-IESNA ARP-8-\ (1983) Roadway Lighting

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE Std 81-\ (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

\-NEMA RN 1-\ (1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

\-NEMA TC 6-\ (1990) PVC and ABS Plastic Utilities Duct for Underground Installation

\-NEMA TC 9-\ (1990) Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 70-\ (1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

\-UL 6-\ (1993) Rigid Metal Conduit

\-UL 44-\ (1991; Rev thru Jan 1995) Rubber-Insulated Wires and Cables

\-UL 467-\ (1993) Grounding and Bonding Equipment

\-UL 486A-\ (1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors

\-UL 514B-\ (1992; Rev thru Apr 1995) Fittings for Conduit and Outlet Boxes

\-UL 651-\ (1989; Rev thru Dec 1989) Schedule 40 and 80 Rigid PVC Conduit

\-UL 651A-\	(1989; Rev thru Dec 1989) Type EB and A Rigid PVC Conduit and HDPE Conduit
\-UL 854-\	(1991; Rev thru Apr 1993) Service-Entrance Cables
\-UL 886-\	(1994; Rev thru Jul 1995) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
\-UL 1029-\	(1994) High-Intensity-Discharge Lamp Ballasts

1..2. SYSTEM DESCRIPTION

1..2..1. Lighting System

The lighting system shall be configured as specified and shown. The system shall include all fixtures, hardware, poles, cables, connectors, adapters and appurtenances needed to provide a fully functional lighting system.

1..2..2. NOT USED

1..2..3. Electrical Requirements

The equipment shall operate from a voltage source as shown, plus or minus 10 percent, and 60 Hz, plus or minus 2 percent.

1..2..4. NOT USED

1..2..5. NOT USED

1..2..6. Interface Between Lighting System and Power Distribution

Conductors shall be as indicated.

1..2..7. Nameplates

Each major component of equipment shall have a nonferrous metal or engraved plastic nameplate which shall show, as a minimum, the manufacturer's name and address, the catalog or style number, the electrical rating in volts, and the capacity in amperes or watts.

1..2..8. Standard Products

Materials and equipment shall be standard products of manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1..3. CORROSION PROTECTION

1..3..1. Aluminum Materials

Aluminum shall not be used.

1..3..2. Ferrous Metal Materials

1..3..2..1. NOT USED

1..3..2..2. Equipment

Equipment and component items, including but not limited to metal poles and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in \-ASTM B 117-\ without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall have a rating of not less than 7 in accordance with TABLE 1, (procedure A) of \-ASTM D 1654-\. Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

1..3..3. Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory, shall be as specified in Section \=09900=\ PAINTING, GENERAL.

1..4. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with section \=01300=\ SUBMITTAL PROCEDURES:

SD-01 Data\

Equipment and Materials\; *GA*\.

Data published by the manufacturer of each item on the list of equipment and material, to permit verification that the item proposed is of the correct size, properly rated or applied, or is otherwise suitable for the application and fully conforms to the requirements specified.

Spare Parts\; *FIO*\.

Spare parts data for each item of material and equipment specified, after approval of detail drawings for materials and equipment, and not later than 4 months before the date of beneficial occupancy. The data shall include a complete list of parts, special tools, and supplies, with current unit prices and sources of supply.

SD-04 Drawings\

Lighting System\; *GA*\.

Detail drawings for the complete system and for poles, lighting fixtures.

As-Built Drawings\; *FIO*\.

Final as-built drawings shall be finished drawings on mylar or vellum and shall be delivered with the final test report.

SD-09 Reports\

Operating Test\; *GA*\.

Test procedures and reports for the Operating Test. After receipt by the Contractor of written approval of the test procedures, the Contractor shall schedule the tests. The final test procedures report shall be delivered after completion of the tests.

Ground Resistance Measurements\; *FIO*\.

The measured resistance to ground of each separate grounding installation, indicating the location of the rods, the resistance of the soil in ohms per millimeter and the soil conditions at the time the measurements were made. The information shall be in writing.

SD-19 Operation and Maintenance Manuals\

Lighting System\; *FIO*\.

A draft copy of the operation and maintenance manuals, prior to beginning the tests for use during site testing. Final copies of the manuals as specified bound in hardback, loose-leaf binders, within 30 days after completing the field test. The draft copy used during site testing shall be updated with any changes required, prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the field test shall include modifications made during installation checkout and acceptance.

PART 2. PRODUCTS

2..1. STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2..2. BRACKET ARMS

2..2..1. On Concrete Poles

Poles shall be provided with bracket arms of the support arm style and of the length indicated on drawings. Bracket arms shall conform to the design of the pole provided. The bracket arms shall be capable of supporting the equipment to be mounted on it with the maximum wind and ice loading encountered at the site. Steel brackets shall be galvanized. Wood bracket arms shall not be used.

2..3. CABLE

The Contractor shall provide all wire and cable not indicated as government furnished equipment. Wire and cable components shall be able to withstand the jobsite environment for a minimum of 20 years.

2..3..1. Insulated Cable

Cable shall be type USE conforming to \-UL 854-\, with copper conductors and type RHW or XHHW insulation conforming to \-UL 44-\, and shall include green ground conductor. Cable shall be rated 600 volts. Parts of the cable system such as splices and terminations shall be rated not less than 600 volts. The size and number of conductors and the number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded.

2..3..2. NOT USED

2..3..3. Bare Copper Conductors

Medium-hard-drawn copper conductors shall conform to \-ASTM B 2-\ and \-ASTM B 8-\.

2..4. NOT USED

2..5. CABLE SPLICES AND CONNECTORS

Cable splices and connectors shall conform to \-UL 486A-\. Underground splices and connectors shall also conform to the requirements of \-ANSI C119.1-\.

2..6. NOT USED

2..7. NOT USED

2..8. CONDUIT, DUCTS AND FITTINGS

2..8..1. Conduit, Rigid Steel

Rigid steel conduit shall conform to \-ANSI C80.1-\ and \-UL 6-\.

2..8..2. Conduit Coatings

Underground metallic conduit and fittings shall be coated with a plastic resin system conforming to \-NEMA RN 1-\, Type 40. Epoxy systems may also be used.

2..8..3. Conduit Fittings and Outlets

2..8..3..1. NOT USED

2..8..3..2. NOT USED

2..8..3..3. NOT USED

2..8..3..4. NOT USED

2..8..3..5. Fittings for Conduit and Outlet Boxes

\-UL 514B-\.

2..8..3..6. Fittings for Use in Hazardous (Classified) Locations

\-UL 886-\.

2..8..3..7. Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

\-UL 514B-\.

2..8..4. Non-Metallic Duct

Non-metallic duct lines and fittings utilized for underground installation shall be suitable for the application. Duct shall be thick-wall, single, round-bore type. Material of one type shall be used. Acrylonitrile-butadiene -styrene (ABS) duct shall conform to \-NEMA TC 6-\ and \-NEMA TC 9-\. High-density conduit shall conform to \-UL 651A-\. Schedule 40 polyvinyl chloride (PVC) shall conform to \-UL 651-\. Plastic utility duct and fittings manufactured without a UL label or listing shall be provided with a certification as follows: "The materials are suitable for use with 167 degree F wiring. No reduction of properties in excess of that specified for materials with a UL label or listing will be experienced if samples of the finished product are operated continuously under the normal conditions that produce the highest temperature in the duct."

2..9. NOT USED

2..10. GROUND RODS

Ground rods shall be of copper clad steel conforming to \-UL 467-\ not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into earth.

2..11. POLES

Concrete poles shall be similar to the detail on sheet ED.1 shall be embedded base type and shall be the pole manufacturer's standard design for supporting the number of fixtures indicated. Poles shall be designed for a wind velocity of 100 mph at the base of the pole, for a wind gust factor of 1.3, and for the height and drag factors recommended by \-AASHTO LTS-2-\. The effective projected area of luminaires and other pole-mounted devices shall be taken into account in pole design. Poles shall have grounding provisions. The type of pole shaft material provided shall not be mixed on any project. Grounding connection shall be provided at each concrete pole anchor base. Scratched, stained, chipped, or dented poles shall not be installed.

2..11..1. NOT USED

2..11..2. NOT USED

2..11..3. Concrete Poles

Concrete poles shall be designed to withstand the loads specified in \-ANSI C2-\ multiplied by the appropriate overload capacity factors. Poles shall be reinforced or prestressed, either cast or spun. Spun poles shall be manufactured by a centrifugal spinning process with concrete pumped into a polished round tapered metal mold. Concrete for spun poles shall have a compressive strength of at least 5,000 psi at 28 days; steel wire shall have

an ultimate tensile strength of at least 120,000 psi; and reinforcing bars shall have an ultimate tensile strength of at least 40,000 psi. After the high speed spinning action is completed, a spun pole shall be cured by a suitable wet steam process. Spun poles shall have a water absorption of not greater than 3 percent to eliminate cracking and to prevent erosion. Concrete poles shall have hollow shafts. Poles shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost. Poles shall not be installed for at least 15 days after manufacture. Fittings and brackets that conform to the concrete pole design shall be provided. Poles shall conform to strength calculations performed by a registered professional engineer and submitted in accordance with detail drawings portion of paragraph SUBMITTALS.

2..12. NOT USED

2..13. NOT USED

2..14. NOT USED

2..15. ILLUMINATION

2..15..1. NOT USED

2..15..2. Roadway Lighting

Luminaires, ballasts, lamps, and control devices required for roadway lighting shall be in accordance with sheet 52 of Standard Detail No. 40-06-04, attached to these specifications.

2..16. LAMPS AND BALLASTS, HIGH INTENSITY DISCHARGE (HID) SOURCES

2..16..1. NOT USED

2..16..2. NOT USED

2..16..3. Metal-Halide

Lamps shall be made by a manufacturer with not less than 5 years experience in making metal-halide lamps. Ballasts shall conform to \-ANSI C82.4-\ or \-UL 1029-\.

2..17. NOT USED

2..18. NOT USED

2..19. LUMINAIRE COMPONENTS

Luminaire components shall conform to the following: attachments, \-ANSI C136.3-\; voltage classification, \-ANSI C136.2-\; field identification marking, \-ANSI C136.15-\; interchangeability, \-ANSI C136.6-\ and \-ANSI C136.9-\; and sockets, \-ANSI C136.11-\.

2..20. LIGHTING CONTROL EQUIPMENT

2..21. PHOTOMETRIC DISTRIBUTION CLASSIFICATION

Photometrics shall conform to \-IESNA ARP-8-\.

2..22. NOT USED

2..23. FIXTURES

Standard fixtures shall be as detailed on Standard Detail No. 40-06-04, Sheet Nos. 52 which accompany and form a part of this specification. Special fixtures shall be as indicated on the drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar design, equivalent light distribution and brightness characteristics, equal finish and quality will be acceptable as approved.

2..23..1. Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

2..23..2. NOT USED

2..23..3. In-Line Fuse

An in-line fuse shall be provided for each fixture, and shall consist of a fuse and a UL approved waterproof fuse holder rated at 30 amperes, 600 volts , with insulated boots. Fuse rating shall be as indicated.

PART 3. EXECUTION

3..1. GENERAL

The Contractor shall install all system components, including government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, \-ANSI C2-\, and contract documents, and shall furnish necessary hardware, fixtures, cables, wire, connectors, interconnections, services, and adjustments required for a complete and operable system.

3..1..1. Current Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Government. The Contractor shall not take any corrective action without written permission from the Government.

3..1..2. Existing Equipment

The Contractor shall connect to and utilize existing lighting equipment and devices as shown. Lighting equipment that is usable in their original configuration without modification may be reused with Government approval. The Contractor shall perform a field survey, including testing and inspection of existing lighting equipment and control lines intended to be incorporated into the lighting system, and furnish a report to the Government. For those items considered nonfunctioning, specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency shall be provided with the report. As part of the report, the

Contractor shall include the scheduled need date for connection to all existing equipment. The Contractor shall make written requests and obtain approval prior to disconnecting any control lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Government approval of these requests. If any device fails after the Contractor has commenced work on that device, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment. The Government is responsible for maintenance and repair of Government equipment. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Government equipment.

3..2. NOT USED

3..3. PREVENTION OF CORROSION

3..3..1. Aluminum

Aluminum shall not be used in contact with earth or concrete, and where connected to dissimilar metal, shall be protected by approved fittings and treatment.

3..3..2. Steel Conduits

Steel conduits shall not be installed within concrete slabs-on-grade. Steel conduits installed underground or under slabs-on-grade, or penetrating slabs-on-grade, shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlap, or shall have a factory-applied plastic resin, epoxy coating. Zinc coating may be omitted from steel conduit which has a factory-applied epoxy coating.

3..3..3. Cold Galvanizing

Field welds and/or brazing on factory galvanized boxes, enclosures, conduits, etc. shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

3..4. CABLE INSTALLATION

Cable and all parts of the cable system such as splices and terminations shall be rated not less than 600 volts. The size and number of conductors and the number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded. Each circuit shall be identified by means of fiber or nonferrous metal tags, or approved equal, in each handhole and at each terminal.

3..4..1. Splices

Splices below grade shall be made with nonpressure-filled resin systems using transparent, interlocking, self-venting, longitudinally split plastic molds. Splices above grade shall be made with sealed insulated pressure connectors and shall provide insulation and jacket equal to that of the cable. In order to prevent moisture from entering the splice, jackets shall be cut back to expose the required length of insulation between the jacket and the tapered end of the insulation.

3..4..2. Installation in Duct Lines

Ground and neutral conductors shall be installed in duct with the associated phase conductors. Cable splices shall be made in handholes only.

3..5. NOT USED

3..6. NOT USED

3..7. NOT USED

3..8. NOT USED

3..9. DUCT LINES

3..9..1. Requirements

Numbers and size of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short radius manufactured 90 degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inches in diameter, and 36 inches for duct 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells when duct lines terminate in manholes or handholes.

3..9..2. Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and shall match factory tapers. A coupling recommended by the duct manufacturer shall be used when an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3..9..3. NOT USED

3..9..4. Nonencased Direct-Burial

Top of duct lines shall be below the frost line depth of 30 inches, but not less than 30 inches below finished grade and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Bottom of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 6 inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be

backfilled and compacted in 3 to 6 inch layers. Duct banks may be held in alignment with earth. However, high tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

3..9..5. Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendation for the particular type of duct and coupling selected and as approved.

3..9..5..1. Plastic Duct

Duct joints shall be made by brushing a plastic solvent on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4 turn to set the joint tightly.

3..9..6. NOT USED

3..9..7. Duct Line Markers

Duct line markers shall be provided at the ends of long duct line stubouts or for other duct locations that are indeterminate because of duct curvature or terminations at completely below-grade structures. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

3..10. HANDHOLES

The exact locations shall be determined after carefully considering the locations of other utilities, grading, and paving. Exact locations shall be approved before construction is started.

3..10..1. Construction

Handholes shall be constructed as indicated on drawings, including appurtenances. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic construction. Concrete shall be 3000 psi at 28 days. Precast concrete handholes having the same strength and inside dimensions as cast-in-place concrete handholes may be used. In paved areas, the top of entrance covers shall be flush with the finished surface of the paving. In unpaved areas, the top of entrance covers shall be approximately 1/2 inch above the finished grade. Where finished grades are in cut areas, unmortared brick shall be installed between the top of handhole and entrance frame to temporarily elevate the entrance cover to existing grade level. Where duct lines enter walls, the sections of duct may be cast in the concrete or may enter the wall through a suitable opening. The openings around entering duct lines shall be caulked tight with lead wool or other approved material.

3..10..2. Appurtenances

The following appurtenances shall be provided for each handhole.

3..10..3. NOT USED

3..10..4. Ground Rods

In each handhole, at a convenient point close to the wall, a ground rod conforming to paragraph GROUNDING shall be driven into the earth before the floor is poured; approximately 4 inches of the ground rod shall extend above the floor after pouring. When precast concrete units are used, the top of the ground rod may be below the floor; a No. 1/0 AWG copper ground conductor shall be brought inside through a watertight sleeve in the wall.

3..11. POLE INSTALLATION

Pole lengths shall provide a luminaire mounting height of 30 feet. Electrical cabling shall be provided to the light pole as specified in this Section. Pole installation shall conform to the manufacturer's recommendations, \-NFPA 70-\, and \-ANSI C2-\. Poles shall be set straight and plumb.

3..11..1. Pole Brackets

Brackets shall be installed as specified by the manufacturer and as shown on drawings. Mounting hardware shall be sized appropriately to secure the mount, luminaire, and housing with wind and ice loading normally encountered at the site.

3..11..2. NOT USED

3..11..3. NOT USED

3..11..4. NOT USED

3..11..5. Concrete Pole Installation

Concrete poles shall be embedded in accordance with the details shown. Conduit elbows shall be provided for cable entrances into pole interiors.

3..12. LIGHTING

3..12..1. Lamps

Lamps of the proper type, wattage, and voltage rating shall be delivered to the project in the original containers and installed in the fixtures just before completion of the project.

3..12..2. Fixture Installation

Standard fixtures shall be installed as detailed on Standard Detail No. 04-06-04, Sheet Nos. 52, which accompany and form a part of this specification. Special fixtures shall be as indicated on drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection of fixtures to any particular manufacturer. Fixtures of similar design, equivalent light-distribution and brightness characteristics, and equal finish and quality will be acceptable as approved.

3..12..2..1. Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be installed as required for proper installation.

3..12..2..2. In-Line Fuses

An in-line fuse shall be provided for each fixture.

3..13. NOT USED

3..14. LIGHTING CONTROL SYSTEM

3..14..1. NOT USED

3..14..2. Time Control Switches

The new light pole will be controlled by the existing time controller.

3..15. GROUNDING

Grounding shall be in conformance with \-NFPA 70-\, the contract drawings, and the following. Grounding conductors shall be soft-drawn, stranded copper. Ground rods shall be driven into the earth so that after the installation is complete, the top of the ground rod will be approximately 1 foot below finished grade, except in handholes.

3..15..1. Ground Rods and Pole Butt Electrodes

The resistance to ground shall be measured using the fall-of-potential method described in \-IEEE Std 81-\. The maximum resistance of a driven ground rod shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, additional electrodes shall be provided as indicated, to achieve the specified ground resistance. The additional electrodes shall be up to three, 10 feet rods spaced a minimum of 10 feet apart3/4 inch diameter. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use \-UL 467-\ approved connectors.

3..15..2. Items to be Grounded

Ground conductors, metallic conduits, junction boxes, and noncurrent-carrying metallic parts of equipment shall be grounded. Connections above grade shall be made with solderless connectors, and those below grade shall be made by a fusion-welding process.

3..15..3. Lighting Pole

One ground rod shall be provided at each pole. Bases of concrete lighting poles shall be connected to ground rods by means of No. 8 AWG bare copper wire. Lighting fixture brackets on concrete poles shall be grounded to a No. 6 AWG bare copper grounding conductor connected to the ground rod.

3..15..4. Handhole

In each handhole, at a convenient point close to the wall, a ground rod shall be driven into the earth before the floor is poured, and approximately 4 inches of the ground rod shall extend above the floor after pouring. When precast concrete units are used, the top of the ground rod may be below the floor, and a No. 1/0 AWG copper ground conductor shall be brought inside through a watertight sleeve in the wall. Connection to ground rods shall be by means of bolted-clamp terminals or by an approved fusion-welding process. Ground wires shall be neatly and firmly attached to handhole walls, and the amount of exposed bare wire shall be held to a minimum.

3..16. TESTS

3..16..1. NOT USED

3..16..2. \+Operating Test+

After the installation is completed and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements specified. The test shall be performed in the presence of the Contracting Officer. The Contractor shall furnish instruments and personnel required for the test, and the Government will furnish the necessary electric power.

3..16..3. Ground Resistance Measurements

The resistance to ground shall be measured by the fall-of-potential method described in \-IEEE Std 81-\.

The contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the lighting to be used for "as-built" drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the lighting system. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Upon completion of the as-built drawings, a representative of the Government will review the as-built work with the Contractor. If the as-built work is not complete, the Contractor will be so advised and shall complete the work as required.

SECTION 16670

LIGHTNING PROTECTION SYSTEM

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1. GENERAL

1..1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

\-ANSI C135.30-\	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 70-\	(1996) National Electrical Code
\-NFPA 780-\	(1995) Lightning Protection Code

UNDERWRITERS LABORATORIES (UL)

\-UL-03-\	(1992) Electrical Construction Materials Directory
\-UL 96-\	(1985; Rev thru Dec 1988) Lightning Protection Components
\-UL 96A-\	(1982; Rev thru Jul 1990) Installation Requirements for Lightning Protection Systems
\-UL 467-\	(1984; Rev thru Nov 1986) Grounding and Bonding Equipment
\-UL 486A-\	(1991; R Oct 91) Wire Connectors and Soldering Lugs for Use with Copper Conductors

1..2. GENERAL REQUIREMENTS

1..2..1. Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work. No departures shall be made without the prior approval of the Contracting Officer.

1..2..2. System Requirements

The system furnished under this specification shall consist of the standard products of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest UL approved design. The lightning protection system shall conform to \-NFPA 70-\ and \-NFPA 780-\,

\-UL 96-\ and \-UL 96A-\, except where requirements in excess thereof are specified herein.

1..3. SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Lightning Protection System\; *GA*\.

Detail drawings consisting of a complete list of material, including manufacturer's descriptive and technical literature, catalog cuts, drawings, and installation instructions. Detail drawings shall demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed layout and mounting and relationship to other parts of the work.

SD-13 Certificates\

Materials and Equipment\; *GA*\.

Where material or equipment is specified to comply with requirements of UL, proof of such compliance. The label of or listing in \-UL-03-\ will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters Laboratories may be submitted.

PART 2. PRODUCTS

2..1. MATERIALS

2..1..1. General Requirements

No combination of materials shall be used that form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, conductors with protective coatings or oversize conductors shall be used. Where a mechanical hazard is involved, the conductor size shall be increased to compensate for the hazard or the conductors shall be protected by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is used, the conductor shall be electrically connected at the upper and lower ends.

2..1..2. Main and Secondary Conductors

Conductors shall be in accordance with \-NFPA 780-\ and \-UL 96-\ for Class I, Class II, or Class II modified materials as applicable.

2..1..2..1. Copper

Copper conductors used on nonmetallic stacks shall weigh not less than 375 pounds per thousand feet, and the size of any wire in the cable shall be not less than No. 15 AWG. The thickness of any web or ribbon used on stacks shall be not less than No. 12 AWG. Counterpoise shall be copper conductors not smaller than No. 1/0 AWG.

2..1..2..2. Aluminum

Aluminum shall not contact the earth nor shall it be used in any other manner that will contribute to rapid deterioration of the metal. Appropriate precautions shall be observed at connections with dissimilar metals. Aluminum conductors for bonding and interconnecting metallic bodies to the main cable shall be at least equivalent to strength and cross-sectional area of a No. 4 AWG aluminum wire. If perforated strips are used, the strips shall be as much wider than solid strips, as the diameter of the perforations.

2..1..3. Air Terminals

Terminals shall be in accordance with \-UL 96-\ and \-NFPA 780-\. On open or hooded vents emitting explosive dusts or vapors under natural or forced draft, air terminals shall be a minimum of 5 feet above the opening. Air terminals more than 24 inches in length shall be supported by a suitable brace, with guides, not less than one-half the height of the terminal.

2..1..4. Ground Rods

Rods made of copper-clad steel shall conform to \-UL 467-\. Ground rods shall be not less than 3/4 inch in diameter and 10 feet in length.

2..1..5. Clamp-Type Connectors

Connectors for splicing conductors shall conform to \-UL 96-\, class as applicable, and \-UL 486A-\, Class 2, style and size as required for the installation.

2..1..6. Lightning Protection Components

Lightning protection components, such as bonding plates, air terminal supports, chimney bands, clips, and fasteners shall conform to \-UL 96-\, classes as applicable.

PART 3. EXECUTION

3..1. INTEGRAL SYSTEM

3..1..1. General Requirements

The lightning protection system shall consist of air terminals, down conductors, ground connections, and grounds, electrically interconnected to form the shortest distance to ground. All conductors on the structures shall be exposed except where conductors are in protective sleeves exposed on the outside walls. Interconnections made within side-flash distances shall be at or above the level of the grounded metallic parts.

3..1..1..1. Air Terminals

Air terminal design and support shall be in accordance with \-NFPA 780-\. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure.

3..1..1..2. NOT USED

3..1..1..3. Down Conductors

Down conductors shall be electrically continuous from air terminals to grounding electrodes. Down conductors shall be protected where necessary, to prevent mechanical injury to the conductor.

3..1..1..4. NOT USED

3..1..1..5. Ground Connections

Ground connections comprising continuations of down conductors from the structure to the grounding electrode shall securely connect the down conductor and ground in a manner to ensure electrical continuity between the two. All connections shall be of the clamp type. There shall be a ground connection for each down conductor. Ground connections shall be protected from mechanical injury. In making ground connections, advantage shall be taken of all permanently moist places where practicable, although such places shall be avoided if the area is wet with waste water that contains chemical substances, especially those corrosive to metal.

3..1..1..6. Grounding Electrodes

A grounding electrode shall be provided for each down conductor located as shown. A driven ground shall extend into the earth for a distance of not less than 10 feet. Ground rods shall be set not less than 3 feet, nor more than 8 feet, from the structures foundation. The complete installation shall have a total resistance to ground of not more than 25 ohms . Ground rods shall be tested individually prior to connection to the system and the system as a whole shall be tested not less than 24 hours after rainfall. When the resistance of the complete installation exceeds the specified value or two ground rods individually exceed 25 ohms, the Contracting Officer will be notified immediately. All connections between ground connectors and grounds shall be electrically continuous.

3..2. NOT USED

3..3. NOT USED

3..4. NOT USED

3..5. NOT USED

3..6. NOT USED

3..7. SEPARATELY MOUNTED SHIELDING SYSTEM, MAST-TYPE

The mast-type protection shall consist of a pole, which, when of a nonconducting material, shall be provided with an air terminal mounted to the top, extending not less than 2 feet nor more than 5 feet above the top of the

pole and a down conductor run down the side of the pole and connected to the ground rod. The grounding system at the base of the pole shall be interconnected with any grounding system provided for the protected structure.

3..8. NOT USED

3..9. INSPECTION

The lightning protection system will be inspected by the Contracting Officer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Contracting Officer.

SECTION 16906

PUMP CONTROL AND ANNUNCIATION SYSTEM

SECTION 16906

PUMP CONTROL AND ANNUNCIATION SYSTEM

PART 1 - GENERAL

1.1 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1.1 American National Standards (ANSI) Publications

C37.90-78 (R 1979)	Relays and Relay Systems Associated With Electric Power Apparatus
C62.41-80	Guide for Surge Voltages in Low Voltage AC Power Circuits

1.1.2 Institute of Electrical and Electronics Engineers, Inc. (IEEE) Publications

472-74 (R 1979)	Guide for Surge Withstand Capability (SWC) Tests

1.1.3 National Electrical Manufacturer's Association (NEMA) Publications

ICS 1-78 (R 1-4, 1983)	General Standard for Industrial Control and Systems
ICS 2-83 (R 3-86)	Standards for Industrial Control Devices, Controllers and Assemblies
ICS 3-83	Industrial Systems
ICS 4-83	Terminal Blocks for Industrial Control Equipment and Systems
ICS 6-83 (R 1, 1983)	Enclosures for Industrial Controls and Systems
LS 1	Low Voltage Surge Protective Devices
250-87	Enclosures for Electrical Equipment (1,000 Volts Maximum)

1.1.4 National Fire Protection Association (NFPA) Publication

70-1996	National Electrical Code

1.1.5 Instrument Society of America (ISA)

Standards for Loop Diagrams

1.1.6 Underwriters' Laboratory Inc. (UL) Publication

1449-87 Transient Surge Suppression

1.2 GENERAL REQUIREMENTS

Section \=16415=\ ELECTRICAL WORK INTERIOR applies to this section, with the additions and modifications specified herein. The Control System Contractor shall be responsible for the entire control system. The Control Contractor shall coordinate with **all** contractors supplying the field devices. The Control Contractor shall be responsible for providing a fully functional control system, in accordance with the drawings and specifications, including the field devices.

1.3 SUBMITTALS

1.3.1 GENERAL

Data shall be submitted in accordance with the overall requirements detailed in Section \=01330=\ SUBMITTAL PROCEDURES and the specific requirements of this section. Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. Documents shall consist of a complete list of equipment and materials, manufacturer's descriptive and technical literature, brochures, catalog cuts, performance specifications, diagrams, and other material as stated in subsequent subparagraphs. The Contractor shall submit additional material if the listed items are not adequate to identify intent or conformance to technical requirements. Any delays associated with resubmittals of incomplete or ambiguous initial submittals will be the Contractor's responsibility.

1.3.2 Submittals

As a minimum the following must be submitted in accordance with the specific subparagraphs noted:

SD-01 Data\

Experience and Qualifications\; *GA1*\

Control System Hardware and Software\; *GA1*\

Supplementary documents demonstrating the accuracy and completeness of the list of material and components, that items proposed comply fully with contract requirements, and are otherwise suitable for the application indicated. Documents shall consist of all data or drawings published by the manufacturer of individual items listed including manufacturer's descriptive and technical literature, performance data, catalog cuts, and installation instructions.

SD-04 Drawings\

Control Ladder Diagram\; *GA1*\

SD-18 Records\

Plan For Instructing Operating Personnel\; *GA1*\

SD-19 Operation and Maintenance Manuals\

Operation and Maintenance Manuals\; *GA1*\

Six copies of O&M manuals, within 7 calendar days following the completion of factory tests.

Operational and Maintenance manuals shall be furnished following the completion of factory tests and shall include:

a. Pump Control Panel assembly including interior and exterior equipment layout.

b. All documents previously submitted and approved with all comments and field changes annotated.

c. Complete description of the sequence of operation including Specification 16920 PLC CONTROL SYSTEM SEQUENCE OF OPERATION and any subsystems not controlled by the PLC (e.g. annunciator panel, EPDS, etc.)

d. Complete listing of all programing of the PLC.

e. Complete relay ladder logic diagrams, PLC input/output diagrams and control power distribution diagrams for the complete control system.

f. Complete guide outlining step-by-step procedures for system startup and operation.

g. Complete troubleshooting guide which lists possible operational problems and corrective action to be taken.

h. Complete maintenance manual for all equipment supplied.

i. Spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

j. The above shall incorporate all as-built conditions.

Documents shall be bound in a suitable binder adequately marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

1.4 NOT USED

1.5 SYSTEM OVERVIEW

1.5.1 General

The facility consists of Railcar Offload/Transfer pumps and the associated control panel that were installed under an earlier contract and the new Truck Offload pumps and required adjustments to be made to the control panel under this contract. The transfer pumps are used to unload fuel from railroad cars

and transfer fuel between storage tanks and transfer fuel from storage tanks across the ramp to the Type III hydrant system. The Truck off-load pumps will unload fuel from Trucks and can also transfer fuel across the ramp to the Type III system. The redundant programmable logic controllers (PLCs) control the starts and stops of the transfer pumps per pushbutton control stations, level sensor control in the air eliminators, and flow switches. The PLCs will be reprogrammed to also control the starts and stops of the truck off-load pumps per pushbutton control stations, level sensor control in the air eliminators, and flow switches.

1.5.2 Interface Components

All power supplies, modules, and interface devices required for a fully functional panel conforming to the design intent herein are existing.

1.6 *EXPERIENCE AND QUALIFICATIONS*

Submit the following data for approval to the Representative of the Contracting Officer :

a. Certification stating that the Control Contractor has built and installed at least five PLC-based systems for controlling pumps.

b. Certification that the control systems have successfully operated over the last 2 years and are currently in service.

c. Project names, locations, and system description of these installations. Include user point-of-contact and current telephone numbers.

1.7 WARRANTY

The Pump Control Panel reprogramming and software shall be warranted for a period of 1 year from the date of acceptance of the system by the Government. This warranty service shall include parts and labor service for equipment supplied under this specification. Upon notification by the Government of system or component failure, the Contractor shall respond at the site with necessary parts within 2 working days.

PART 2 PRODUCTS

2.1 NOT USED

2.2 PUMP CONTROL PANEL COMPONENTS

2.2.1 NOT USED

2.2.2 NOT USED

2.2.3 NOT USED

2.2.4 NOT USED

2.2.5 NOT USED

2.2.6 Alarm Annunciator

The Alarm Annunciator is existing it provides visual annunciation, local and remote monitoring, constant or flashing visual and audible alarm as specified herein. The new tank alarms as shown on the drawings will be connected into this annunciator and the annunciator will be adjusted to display these new alarms accurately.

PART 3 EXECUTION

3.1 CONTROL PANEL COMPONENTS

The control panel is existing and all reprogramming will need to occur at the job site.

3.1.1 NOT USED

3.1.2 Sequence of Operation

See Specification 16920 PLC CONTROL SYSTEM SEQUENCE OF OPERATION and drawings for the programming of the PLC.

3.1.3 Programs

The Contractor shall provide a copy of all working programs (i.e. PLC logic) on 3-1/2 inch floppy disks as well as a printer program listing. At system start up, debug, and testing the Contractor shall provide personnel, on site, to provide technical assistance, program fine tuning, and to demonstrate the system.

3.1.3.1 The Contractor (programmer) shall provide rung comments (documentations) in the ladder logic program. Each device, on the ladder, shall be identified as to the type of device, i.e. limit switch XX, flow indicator XX, motor starter XX, etc.. Rung comments shall be provided for input and output rungs. The programmer shall also provide a comment describing the function of each rung.

3.2 *CONTROL LADDER DIAGRAM*

The Control Contractor shall submit a detailed control ladder diagram for the control panel. The diagram at a minimum shall show:

a. Power connections between surge arresters, power supplies, PLCs, etc.
b. Power and control connections between field devices and PLC I/O modules.

The diagram shall be clear and readable and preferable drawn using a computer aided drafting package. At the conclusion of the project the diagram drawings shall be redrafted to include all as-built conditions. These updated drawing shall be included in the O & M Manuals and appropriate sections of the drawings placed in a data pocket located in the control panel.

3.3 INSTALLATION

Installation shall conform to the manufacturer's drawings, written recommendations and directions.

3.3.1 Field Service

The Contractor shall provide technical field personnel for the purpose of placing the control system in operation and making necessary adjustments to ensure optimum operation. Upon completion of the work and at a time designated by the Contracting Officer, furnish the services of a competent technician regularly employed by the Control Panel manufacturer for the instruction of Government personnel in the operation and maintenance of the system. Provide both classroom type theory instruction and hands-on instruction using operating equipment provided. The period of instruction shall be for not less than one 8-hour working day.

3.3.2 *Plan for Instructing Operating Personnel*

Furnish a written lesson plan and training schedule for Government approval at least 60 days prior to instructing operating personnel. This plan shall be tailored to suit the requirements of the Government. The training program shall provide:

a. a detailed overview of the control system
b. a general overview of Programmable Logic Controllers
c. the maintenance of equipment installed
d. the programming of the PLC
e. trouble shooting of the system

Complete approved Operation and Maintenance manuals for Specification 16906 and 16415 (specifically pertaining to the motor control center and it's relay ladder diagrams) shall be used for instructing operating personnel. Training shall include both classroom and hands-on field instruction. The class shall be video taped in the VHS format.

3.3.3 Field Inspection and Tests

Testing shall be coordinated with the overall Fueling System start-up test specified in specification section "SYSTEM START-UP, FUELING". Prior to this test, all field connections shall have been made and interconnection to the control panels. In addition, wiring shall have been checked for continuity and short circuits. Perform tests in such a way as to obtain information about the performance of the control panel and field devices. Tests shall be performed or supervised by competent employees of the system supplier. A fourteen day notice of testing shall be given to the Contracting Officer. If the Contracting Officer witnesses tests, such test shall be subject to approval. If the Contracting Officer does not witness tests, provide performance certification. Field inspection and tests shall be performed as stated in approved inspections and test plan.

SECTION 16920

PLC CONTROL SYSTEM SEQUENCE OF OPERATION

SECTION 16920

PLC CONTROL SYSTEM SEQUENCE OF OPERATION

PART 1. GENERAL (Not Applicable)

PART 2. PRODUCTS (Not Applicable)

Part 3. EXECUTION

3..1. TRANSFER PUMPS

3..1..1. Mode Switch

Each of the four transfer pumps located in the pumphouse, have a three position mode switch (Railcar Offload, Off, Transfer) on the front of the control panel to send the signal to the PLC of the users intentions for that particular pump. A maximum of two transfer pumps may be used for railcar offload at the same time. Up to four transfer pumps could be used for fuel transfer.

3..1..2. Railcar Offload Pump Control

The operator will set the Air Eliminator #1 and/or #2 Pump control switches to correspond to the transfer pumps that have been chosen to offload railcars. A "Start" or a "Stop" signal from the start stop pushbutton stations located on the control panel will be inputs to the PLC. The PLC will then send a "Start" signal to the appropriate motor starter circuit according to the following rules:

a. Each "Start" and "Stop" pushbutton is a momentary contact type and the PLC shall hold in memory the status of each pushbutton (Start or Stop).

b. A "Start" from the pushbutton will start the pump if the associated air eliminator low fuel level sensor is satisfied. If the pump is alowed to start, the PLC will light the "Run" light and de-energize the "Stop" light.

c. The PLC will stay in control of the Railcar offload operation in the following ways. With the low level sensor satisfied the pump will remain running and the flow control valve will be modulated to 25% open. When the medium level sensor is satisfied, the solenoid control B on the flow control valve will be energized which will modulate the valve to 50% open. When the high level sensor is satisfied the solenoid control A on the flow control valve will be energized which will modulate the valve to fully open.

d. As the Railcar is emptying the low level sensor in the air eliminator will not be satisfied. When this occurs the PLC will send a "Stop" signal to the pump motor, as the pump is stopping the flow control valve will close, the "Stop" light will light and the "Run" light will be deenergized.

e. A "Stop" from the pushbutton with an active "Start" shall turn off the pump, de-energize the solenoids A and B if they were energized, de-energize the associated "Run" light, delete the pushbutton "Start" in memory and energize the associated "Stop" light.

f. A flow switch is located downstream of each pump. The PLC will monitor the status of each flow switch. Anytime after a pump has been running for 10 seconds, a pump which has been given a "Start" signal has not closed its associated flow switch, or the flow switch comes open, the PLC will cause the pump to be sent a "Stop" signal and will annunciate a pump failure in the alarm annunciator panel.

3..1..3. Transfer Pump Control

A "Start" or a "Stop" signal from the pushbutton stations (for transfer of fuel between tanks or across the ramp) on the Pump Control Panel will be inputs to the PLC. The PLC will then send a "Start" signal to the appropriate motor starter circuit following the following rules:

a. Each transfer pump that has been placed in the transfer mode by the mode switch shall be controlled directly by its "Start" and "Stop" pushbuttons.

b. The PLC shall cause solonoids A and B to be energized as soon as "Start" signal is received. The solenoids shall be deenergized as soon as a "Stop" signal is received.

c. A flow switch is located downstream of each pump. The PLC will monitor the status of each flow switch. Anytime after a pump has been running for 10 seconds, a pump which has been given a "Start" signal has not closed its associated flow switch, or the flow switch comes open, the PLC will cause the pump to be sent a "Stop" signal and will annunciate a pump failure in the alarm annunciator panel.

d. A "Stop" from any pushbutton with an active "Start" in memory shall turn off the pump, de-energize the associated "Run" light, delete the pushbutton "Start" in memory, and energize the associated "Stop" light.

3..1..4. Railcar Offload and Transfer Simultaneous Pump Control

The above sequence of operations are for stand alone Railcar Offload and Transfer operations. Railcar Offload and Transfer operations may occur simultaneously. In general, under simultaneous operation the stand alone sequence is to be used for each pump according to what status (Offload,Off, Transfer) it has been placed in.

3..2. TRUCK OFF-LOAD PUMPS

There will be three Truck Off-Load pumps installed under this contract. The existing PLC control system has the capability to preform the following control functions. Each pump will serve two off-load stands. The following sequence will describe the controls for one off-load pump, the other pump's controls will be identical. Each pump will function independently from the others.

3..2..1. Truck Off-Load Pump Control

A "Call" (for fuel pump start) or a "Cancel" signal from any of two (2) pushbutton stations (one at each of the Offload Stands associated with that pump) will be inputs to the PLC. The PLC will then send a "Start" signal to the appropriate motor starter circuit according to the following rules:

a. Each "call" and "cancel" pushbutton is a momentary contact type and the PLC shall hold in memory the status of each station (call or cancel).

b. A "call" from either Offload Stand pushbutton station will start the pump if the associated air eliminator low fuel sensor is satisfied. If the pump is allowed to start the PLC will light the "Run" light at the associated station and on the PCP and de-energize the "Stop" light.

c. A second "call" from the other Offload Stand pushbutton station while the pump is running will, increase the number of calls held in memory to two.

d. The PLC will stay in control of the Truck Offload operation in the following ways. With the low level sensor satisfied the pump will remain running and the flow control valve will be modulated to 25% open. When the medium level sensor is satisfied, the solenoid control B on the flow control valve will be energized which will modulate the valve to 50% open. When the high level sensor is satisfied the solenoid control A on the flow control valve will be energized which will modulate the valve to fully open.

e. As the Truck is emptying the low level sensor in the air eliminator will not be satisfied. When this occurs the PLC will send a "Stop" signal to the pump motor, as the pump is stopping the flow control valve will close, the "Stop" light will light and the "Run" light will be deenergized.

f. A "Cancel" from the pushbutton with an active "Call" shall turn off the pump, de-energize the solenoids A and B if they were energized, de-energize the associated "Run" light, delete the pushbutton "Call" in memory and energize the associated "Stop" light.

g. A flow switch is located upstream of each pump. The PLC will monitor the status of the flow switch. Anytime after a pump has been running for 10 seconds, a pump which has been given a "Start" signal has not closed its associated flow switch, or the flow switch comes open, the PLC will cause the pump to be sent a "Stop" signal and will annunciate a pump failure in the alarm annunciator panel.

h. A "cancel" from any Offload Stand pushbutton station with an active "call" while the PLC has two "calls" in memory shall, decrease the number of "calls" from Offload Stand pushbuttons in memory by one.

i. A "cancel" from the last Offload Stand pushbutton station with an active "call" shall turn off the pump, de-energize the associated "Run" lights, delete the last Offload Stand "call" in memory and energize the associated "Stop" light.

3..3. MISCELLANEOUS

3..3..1. Operating Tanks

3..3..1..1. Level Control

Each operating tank has two level float switches to measure high and high-high levels. The switches are DPDT for redundancy and each pole shall be connected to separate input modules.

3..3..1..1..1. High Level

When the high level float is activated the alarm annunciators high level alarm non-critical alarm sequence activates.

3..3..1..1..2. High-High Level

When the high-high level float is activated the alarm annunciators high-high critical alarm sequence activates.

3..3..2. Emergency Power Down Station (EPDS) Pump Control

There are EPDS stations located at each Truck Offload Stand and in the Pumphouse. The EPDS circuit shall give the PLCs a signal when activated (Relay ES). The PLCs shall cancel all "calls" from truck Offload Stands and all "starts" from the Railcar Off-Load Stand pushbutton stations which results in a STOP signal to all motors.

The PLCs shall not accept any "calls" or "starts" until the EPDS circuit has be reset by the use of the Reset pushbutton on the PCP therefore, changing state of relay ES.

3..3..3. Pump Control Panel Indicators

A closed Transfer Pump Status Relay (SR1 thru SR4) input to the PLC shall light the Run light and start the elapsed time meter of the appropriate pump. An open Status Relay will light the Stop light.

A closed Off-Load Pump Motor Controller auxiliary Relay (MC1 thru MC3) input to the PLC shall light the Run light and start the elapsed time meter of the appropriate pump. An open Relay will light the Stop light.